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A Dispatching System for Works Management

The Bullard Machine Tool Company's Charts Showing at a Glance Costs and Progress, Past and Future, and Insuring Orderliness, and Exact Balance of Equipment

BY JOHN NELSON

The dispatching system has come to be recognized as an indispensable adjunct of the well managed manufacturing plant. In practice, however, it varies greatly in effectiveness, and in the very important item, the cost of maintenance. In some cases it is of doubtful value, in others it is a source of actual misinformation. To produce the kind of results that count, a simple, practical, cheaply operated method must be devised. It must automatically afford quick information as to the status in the works of each order and each part which enters into the product. The department must give, at all times, the location of work in the shop. The system should also show the time and money which have been expended upon a lot of machinery at any moment during its progress through the plant, and a close estimate of the time and money which must be spent before the order is completed.

The Bullard Machine Tool Company, Bridgeport, Conn., has had in operation for some time a dispatching system which was developed and has been carried on by J. L. Sydnor, the company's efficiency manager. The methods employed are essentially efficient as well as quite unique in several respects, when compared to accepted practice, and have proved to be invaluable in the operation of the large shops, which build vertical turret lathes and boring mills and their accessories. Moreover, the system is operated at relatively small cost because of its simplicity. It is a most essential factor in its relation to the bonus system of wages under which the works are operated.

WHAT THE CHARTS SHOW OF WORK IN PROCESS OF MANUFACTURE

The relation of the work on an order in all departments in respect to one another as to time.

The date of beginning and the estimated date of ending of work of each department, on a given percentage of shop capacity.

The estimated number of productive hours which each department will require for producing a lot of machines.

The progress of the work through each department, week by week, in productive hours.

The condition of each department and the exact apportionment of productive hours among orders at all times.

The time and money expended to date on each order as a whole or by departments. An average hourly wage affords a sufficiently accurate basis for calculation.

The estimated time and cost required to complete any order in process, as a whole or by departments.

The limits of productive hours between which the works can be operated economically.

The basis of the dispatching system consists of three graphic charts, which in combination constitute a constant source of exceedingly valuable information. What they show is given in the accompanying enumeration.

In every-day practice the dispatching department has ascertained, inside of half an hour, the exact cost to date of every machine in process in the works and the estimated amount of money which would be required to complete all orders.

The Graphic Charts

The master chart reproduced on page 2 shows for each order the relation of each department to all of the others, together with the date of beginning the work and the estimated date of completion, and the progress achieved by each department by weeks, all as indicated.

The departmental chart, of which there is one for each department, is shown on page 3. It gives the apportionment of productive hours between orders and the detailed progress of the department as a whole.

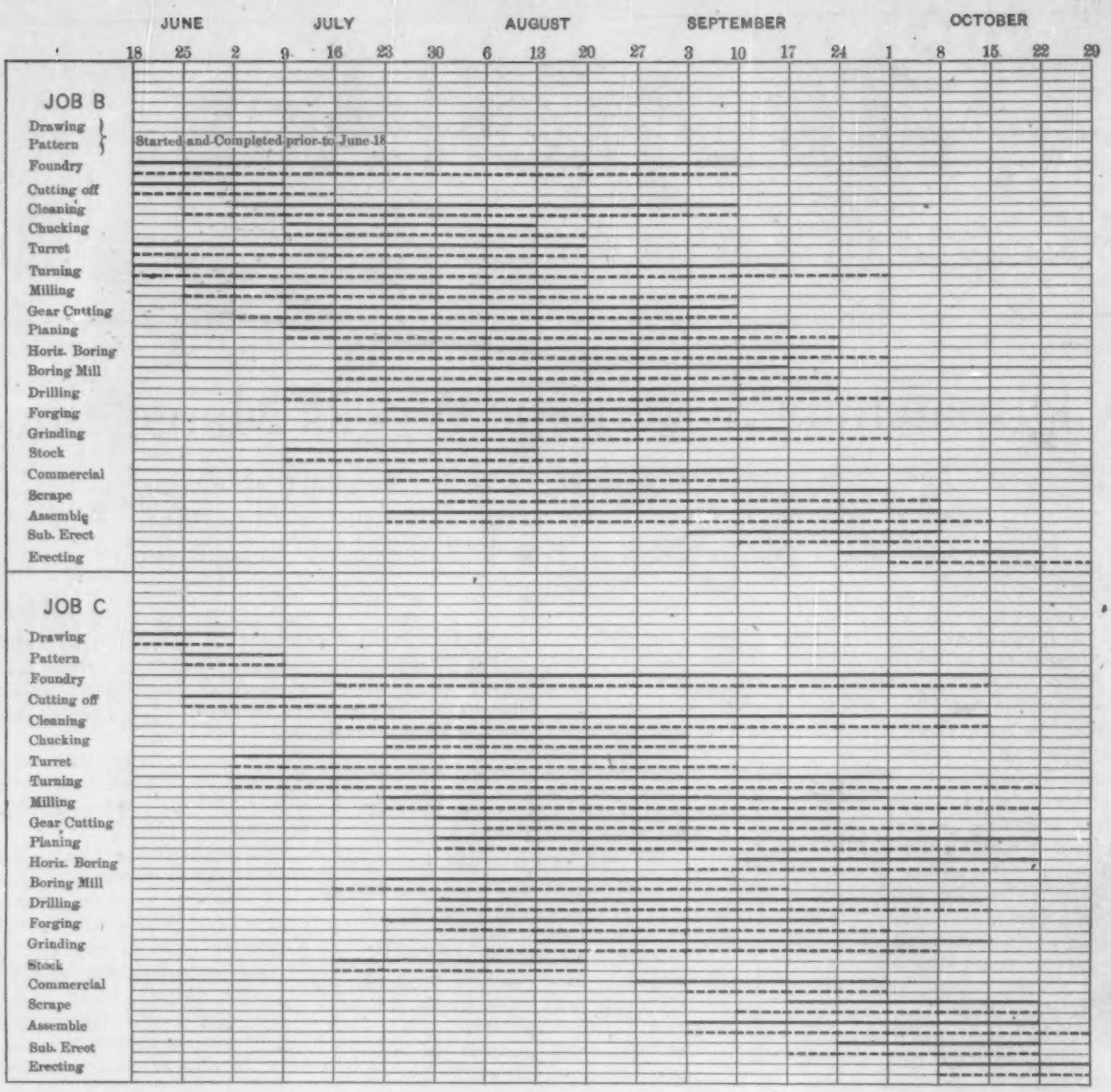
The general chart, which shows the progress of all orders in the works by total productive hours, is presented on page 4.

The dispatching system goes far in its operation in that it gives immediate information of the progress of each part of a machine through the shops, its location by departments being always indicated by a system of cards shortly to be described. All figures used in the illustrations are, of course, entirely fictitious but serve to illustrate the principles involved. Charts and cards do not bring results in themselves. They are the reminders which insist constantly that the management shall carry through a system which will procure economy and expedition. The personal equation is the great factor in all efficiency work, but without the system the human element is seriously handicapped.

Each item of each chart has two lines, the unbroken line indicating the estimated time, the dotted line the progress of each order, the latter being added to weekly. In the master chart, the line of estimate represents the period between starting and ending the work of each department. It does not represent productive hours, excepting that a department, in order to produce work indicated by this line, shall require a certain number of productive hours in order to bring its task to completion on the given date.

In the other charts, the line of estimate represents a number of productive hours, and its beginning and ending must correspond with the dates as shown in the master chart, with such corrections as may come from changing the percentage of capacity at which the plant is operated and occasionally from certain emergency conditions.

A study of the master chart will show the vertical columns representing weeks and the horizontal columns, departments. In the departmental charts the vertical columns also stand for weeks and months, but the horizontal spaces are given up to orders, all lots in process being represented. Each of these latter spaces is subdivided by ten lines, the purpose being to assist in the rapid reading of the contents without reference to figures. If the time re-



THE MASTER CHART

Showing the Co-Relation of all Departments in Elapsed Time Between the Dates of the Beginning and Ending of Work on Each Order. —— Standard Time Allowance. - - - - Actual Time Taken

quired for a department to complete its work on an order is, for example, 800 hr., the line of estimate is placed on the eighth of the ten division lines. The line of progress, plotted each week, begins at zero, and ascends with the advancement of the work. When 200 hr. have been consumed, the curve has reached the second line; at 300 hr. the third, and so on until, when the work is completed, the line should practically coincide with that of the estimate.

Laying Out the Charts

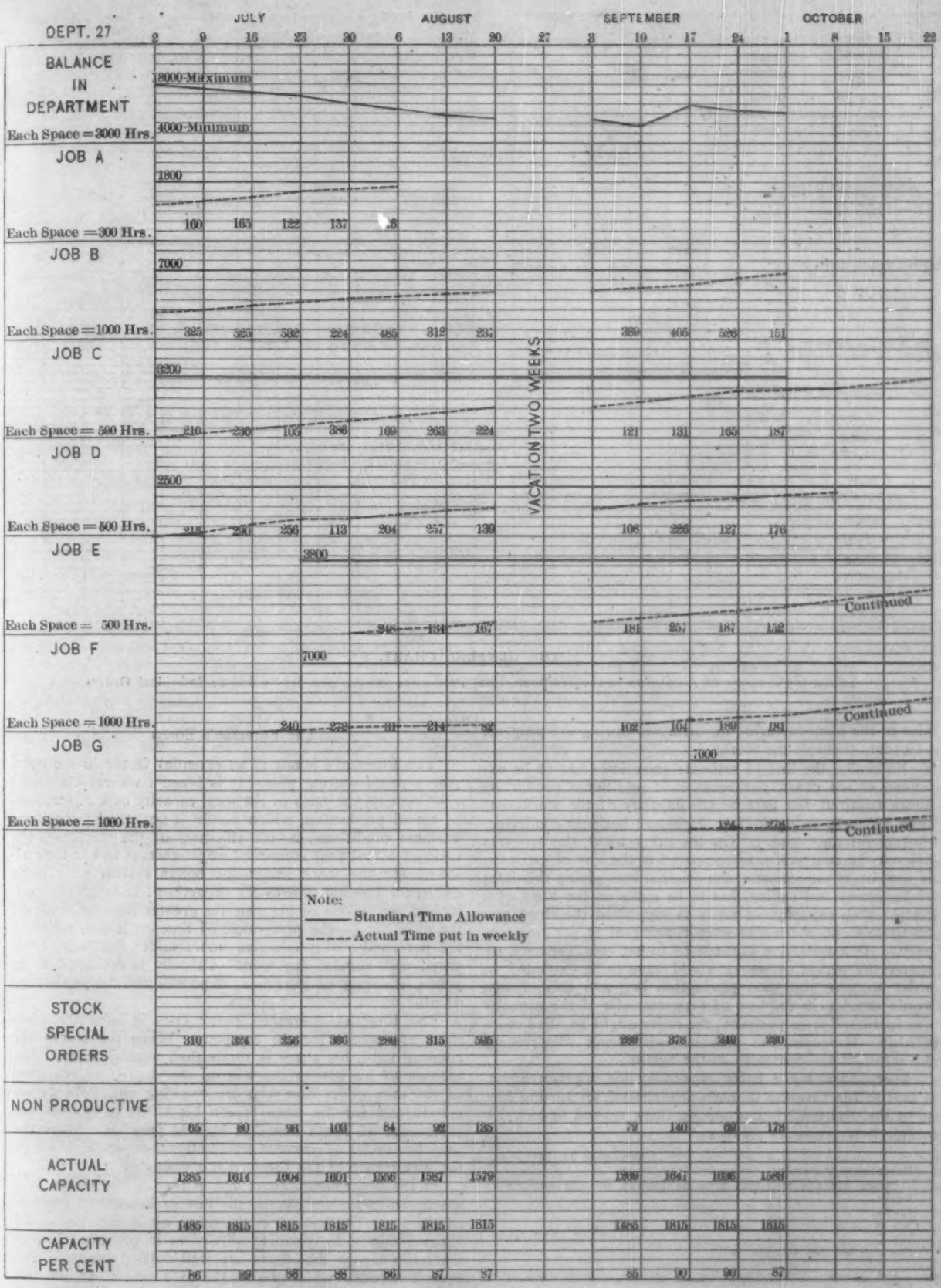
When an order is about to enter the works, the necessary data are placed on the master chart. If the lot of machines is a duplicate of one or more that have gone before it, the time required by each department is easily procured from the cost records. If it is a new type of machine or changes have been made, a certain amount of estimate will have to be included, but experience has shown that figures arrived at by this means are, for practical purposes, as correct as those taken from cost cards.

The dispatching department, studying the order, begins the master chart at a certain date with castings. In the case of the Bullard Company, which operates no foundry, this line represents the time which the foundry company that supplies this raw material is given to make deliveries. The planing, of course, cannot commence until the castings are received, and therefore the line of the department does not start until later. On the other hand, the cutting off, the screw machine and certain other departments may economically begin their portions of the work almost immediately if their conditions warrant it.

Every master chart is reproduced on a grand master chart which is suspended on the wall of the dispatching department, so that every order is there shown. At the Bullard plant the roll of cloth paper makes provision for the record of four years without renewing.

The same apportionment of time is made on the departmental chart. This is a very important record. A moment's inspection tells the distribution of work in hours in a department. If, for example, the department has 1000 productive hours, one order may have 300, another 100, another 200, and so on up to the capacity. This allowance may be changed from week to week. If a rush order for a certain type of machine is received it is a very easy matter to concentrate on one particular lot in process and sacrifice the others for the time being, or an examination of the situation may demonstrate the value of putting on more men and increasing the capacity of one or all departments, as the case may be.

The third chart, as has been stated, contains the progress of all orders, the lines representing the total number of productive hours which it is believed will be required and which have been expended. Of course, in works like those of the Bullard Company, which manufactures on a large scale, the orders are of such size that the totals of productive hours are very large. Yet it has been demonstrated time and time again that the actual time expenditure checks up within a very small percentage of the estimate, which means that the actual cost is almost exactly that of the estimate. Even where a new model is built and the work is not based on experience the variation is not a wide one. Practically the only difference is the saving which results



THE DEPARTMENTAL CHART,

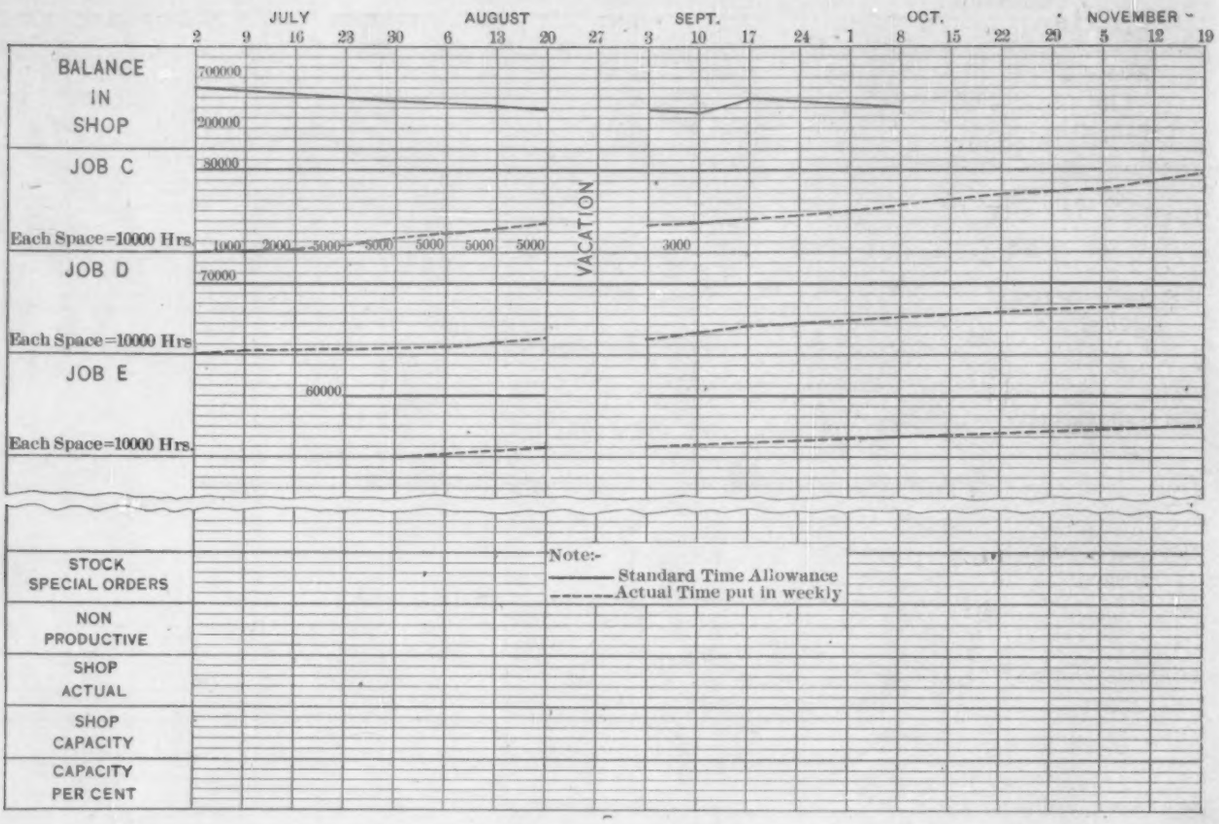
Giving the Apportionment of Productive Hours Among Orders, and Their Dates of Beginning and Ending

from the efficiency system in use in the works, which includes the bonus system.

Dispatching and the Bonus System

The company is constantly seeking more economical methods of manufacturing and means of decreasing wasted energy, which effort naturally has its effect on costs. As a matter of fact, one of the very important functions of dispatching is its co-relation with the payment of rewards in the bonus system. These are dependent one upon the other to a large extent in producing the best results.

It is an accepted principle that if a workman can have all of a lot of parts for assembling his task is more cheaply done than if he gets them a few at a time. The dispatching system serves not only to bring together the full number of parts, but the right parts at the right time. This advantage is felt not only in the assembling department but



THE GENERAL CHART,

Telling the Progress of All Orders in the Works in Total Productive Hours, as a Whole and as Individual Orders

also in the manufacturing departments during the progress of orders through the works.

Naturally, the line of estimate sometimes has to be extended on its chart, not because of additional productive hours required, but because the capacity of the works has been reduced, owing to, say, depressed business conditions throughout the country. On the other hand, the progress line may be contracted, as compared to the line of estimate. If 5000 hr. is the estimate, the original line, giving the dates of beginning and ending, has to be made on the basis of a certain shop capacity. That is to say, when the chart was first made out, the works were running at 75 per cent. capacity. If a reduction is made to 50 per cent. capacity, of course the period of weeks would have to be extended, in order to give the 5000 productive hr., and this change would develop in the line of progress. Or if the capacity was increased to 90 per cent., the order might be filled more quickly. However, this makes no difference whatever in the result of the operation of the system.

Every Saturday a letter, signed by the superintendent, is sent to the foreman of each department, instructing him as to the division of time among these several orders. A sample letter reads as follows:

December 23, 1911.

Department Foreman:

Please arrange to spend time as follows for the ensuing week:

Job A	200 hr.
Job B	300 hr.
Job C	250 hr. should finish
Stock order and accessories	100 hr.

For the week ending December 16, your department stood as follows:

Capacity	85%
Men's efficiency	90%
Time on bonus	93%

The foreman is consulted in relation to these details. If he cannot conform to the instructions, he makes a delay report, a blank for which is shown among the illustrations. The foreman may not have the material, or there may be some question of expediency. These conditions are supposed to be attended to in advance, but, of course, a certain percentage of error must creep into any system. The delay report constitutes a check which automatically operates in the dispatching system to correct errors of omission and judgment.

The Foreman's Bonus

The foreman's bonus is an essential factor in the company's profit-sharing plan. It is based on three elements: 1.—Capacity, the ratio of the total capacity of a department to actual production, which factor is governed by general business conditions; 2—the efficiency of the workmen, the ratio of actual time consumed in production to the time allowed for the work under the bonus system (the more efficient a foreman makes his department through the ability and application of his men, the greater his own share of the profits); 3.—the percentage of time on bonus, which is the percentage of productive hours under bonus as compared with regular day work. Capacity is reckoned as 40 points, efficiency of workmen, 20 points, and the percentage of time under bonus, 40 points.

The foreman, therefore, participates in earnings when there are profits for the company. When the works are running light, his share is diminished automatically. The amount of his profits depends on the degree of efficiency of the men under him who are working under the bonus system and for the same reason his effort is to keep the percentage of bonus hours as high as possible. The company has under advisement an additional schedule in which the importance of the foremen is recognized.

In the deparmental chart and in that of the works as a whole, an important item is the line of balance of productive hours. The balance is the name given the number of hours required to complete all orders in process. Experience has shown that there are well defined limits in this respect between which the works as a whole, on the one hand, and each department, on the other, can be operated economically. This line is shown in the upper horizontal division of the departmental and general charts.

In the departmental chart these limits are given as 4000 and 18,000. The footings of the chart show the weekly reduction from the balance in "hours consumed." In the sample chart, starting from the 18,000 maximum, the first week reduces the balance by 1285, and the line takes a proportionate drop. The balance falls each week until September 17, when a new job is started, adding 7000 hr., and the line of balance goes up correspondingly. It is like a bank account, increasing with each deposit and dropping off with each withdrawal.

This chart shows also productive time consumed on "stock special orders" and time which is non-productive. It also gives the capacity by departments, which in comparison to actual time consumed, produces the percentage capacity at which the department is operated—the factor which enters into the foremen's profit sharing.

The general chart is a continuous productive labor inventory. It tells the management the amount of work it has undertaken to perform; in other words, the liability that has been assumed. The exact status of the shop is recorded each week by individual orders and for the entire product. The chart tells what the company has spent each week and where the money has gone. If costs are exceeding the estimate or if a saving is being made, the fact is revealed graphically. The actual labor cost on which prices are based is told in advance and so is the date of completion. If delay has occurred, the fact is immediately shown, for in such a case the curve of progress ceases to ascend, and continues horizontally through the period of idleness.

Keeping Track of Parts in Process

Not only does the dispatching system give accurate information as to the progress of orders as a whole, but it also keeps track of each lot of parts of machinery. At any moment in the day the department can tell where in the shops any parts may be found. As a great many parts have to go to a considerable number of departments the lack of such knowledge is certain to produce chaotic ignorance. The system begets orderliness, and this in a manufacturing plant means economy because of increased efficiency. The elemental unit of the system which looks after the parts is known as the master card, shown on page 5.

Each part has its master card on which are columns for four orders. That used as an illustration keeps accurate track of the progress of the saddle of the crosshead. It contains on one side the drawing number, material, number of pieces, and so on. It shows that the castings were ordered from the foundry company, under a certain order

Std. Time 1.5 Hours Div. 6R.
Name Saddle No. 1-601 a.c.
Operation Planing complete
Job No. 125

THE DISPATCHING CARD,
The Telegraphic Message of the System

number and include 50 pieces. The date of the order and the date when delivery is due are given, and that of actual delivery is included. Incidentally, this is a constant check on the foundries and serves to regulate deliveries, so that castings are received in the order in which they are required. Consequently, the stock of castings on hand, in other words, the money tied up in raw material in the yard and storehouse, is materially reduced.

This card goes into a drawer which is subdivided by departments. It is the tell-tale of the dispatching system. It passes in the drawer from one department to another, just as the work passes along through the shop. Therefore, to find out where the work is one has only to locate the card. On the reverse face of the card against each department is a column, as also here shown, giving the bonus standard time in hours and columns showing the date of receipt of the lot of parts and the date of their completion, the two columns being known as "in" and "out." Duplicate columns for the time are for use where the lot is split in two sections.

St'd Route	STD. TIME	JOB 125 IN	JOB 125 OUT	JOB 125 IN	JOB 125 OUT	JOB 167 IN	JOB 167 OUT	JOB 167 IN	JOB 167 OUT	JOB IN	JOB OUT	JOB IN	JOB OUT	JOB IN	JOB OUT	JOB IN	JOB OUT
Cleaning	.25	2/11	2/12														
Filling	.4	2/12	2/15														
Planing	1.5	2/15	2/24														
Drilling	.5	2/24	2/27														
Boring Mill	.2	2/27	2/28														
Milling	.3	3/1	3/3														
Scraping	3.	3/4	3/7														
Assembling	5	3/7	3/25														

NAME Saddle	DIVISION Cross Rail	PIECE No. 1-601 A,B		
DWG. No. 11586	MATERIAL C.S.	SIZE	STYLE No.	
JOBS	125	167	190	No. PER MACHINE 1 220
ORDERED FROM	A.B.F. Co.	A.B.F. Co.		
ORDER No.	1050	1509		
No. ORDERED	50	50		
DATE ORDERED	Jan. 10-10	June 5, 1910		
DATE DUE	Feb. 10-10	June 7, 1910		
DATE and No. RECEIVED	Feb. 9, 35 Feb. 11, 15	June 8, 25 June 10, 25		

THE MASTER CARD,

Which Keeps Track of Each Part Through Every Department in the Works. The Upper Half of the Cut Shows the Reverse Side of the Master Card, Showing the Standard Route Through the Works, Giving Standard Time for Bonus System and the Actual Time Consumed in Each Department

The Blue Dispatch Card

On this page is shown the blue dispatch card. It is the telegram message which is sent out from the office to notify the foreman of a department to start work on a lot of parts. Its operation is analogous to the dispatching system of a well-managed railroad. The railroad has a chief dispatcher who is responsible to the superintendent only. His division is divided into blocks, each of which has its station operator. The chief dispatcher directs the operation of all trains in all details. The responsibility of a station operator is to report the entrance and departure of trains in relation to his block. In the Bullard shops the superintendent's office is the chief dispatcher. The shop clerks are the station operators. The dispatch cards are the messages between the superintendent's office and the manufacturing departments.

The card tells the foreman the standard time by hours for his bonus system and gives the operations required for the work in the department. The moment the department has finished the order the card returns to the office as a notification of progress. It is an order to move the master card to the next department in the drawer, and to forward another dispatch card to the corresponding department in the works. The operation of the dispatch cards continues until finally the master card has left the drawer, the work being completed. When all the cards representing an order have been assembled as finished the lot of machines is ready for delivery to customers.

The dispatch cards go to another drawer, where they tell the story of the progress of the machine as a whole. The drawer is divided longitudinally into two divisions, one for work which is to be done, the other for completed work. The entire group representing an order is made ready before

manufacturing commences, and the thick bunch of cards is placed in the left-hand side of the drawer. Upon their return, one by one, from their departments, they go into the "finished" side of the drawer. A glance shows the progress of the machine. In the case in question, when all the blue cards having to do with the saddle have changed sides, the order for the saddle has been completed. Both master and dispatch cards are used over and over again, with each order containing the part.

A tag, of which a reproduction to one-half size is here given, accompanies the work for the convenience of workmen and inspectors. As will be noted, it gives a good deal of information which is frequently of value. In addition, there is a special replacement card and its master card, for use when it is necessary to replace any work where defects have developed. In this connection a card is provided as a "Spoiled or Defective Material Report." This card, as indicated, is filled out by the inspector or foreman who rejects work or material.

THE BULLARD MACHINE TOOL CO.
DEPARTMENTAL DELAY REPORT.

Dept. Date 191

SUPERINTENDENT:—
Work in this Department will fall behind Shop Schedule unless following material is furnished immediately.

JOB ORDER No.	No. PIECES	MATERIAL	REMARKS

Foreman

The Departmental Delay Report

Obtaining a Balance of Equipment

In the beginning the system demonstrated immediately that the shop lacked balance in its equipment, a very common condition in works using machine tools. For example, the original chart lay-out for orders contemplated and in progress indicated that one department would require additional machines in order to do its share of the work. When the foreman of the department was told this he laughed and said that, on the contrary, he had too many machines and that he was contemplating laying off a man or two. The system did not lie. The new machines were installed and the balance was found to have been adjusted. The same condition existed to a greater or less extent in other departments.

We have already spoken of the orderliness of the system and its results. An excellent proof is afforded in the erecting department, which had been suffering because of the failure of the works to deliver parts of machines coincidentally. Men were laid off some of the time when they should have been working. The assembling department was rushed or idle by intervals. Under the dispatching system this department, working continuously, so increased its output that it became necessary to add to the erecting force, which also works with no let-up caused by delay in manufacturing departments.

The erecting department stock room is a striking commentary on the benefits of orderliness. It had been found practically impossible to create a stock of assembled units. To-day a large room is required for their storage. Analyzed, this means that instead of parts of machinery being stored at haphazard through the shop departments in various stages of completion, they are gathered together ready to be assembled by the erecting department. The erection of a machine is now never begun unless all of the units which enter into it are tested and in the stock room.

THE B. M. T. CO. MATERIAL
ORDER DEPT.

50
No. Pieces Required

Job 125
Division Cross Rail
Name Saddle

Piece No. 1-601 ac Hole
Style No. A. B.
Drawing No. 11586
Size—
Per Dept.

NO. PIE.	OPERATIONS	O K
	Cleaning	
	Filling	
	Planing	
	Drilling	
	Boring Mill	
	Milling	
	Scraping	
	Assembling	

The Tag Which Accompanies the Order Through the Works

Advantages in Determining Delivery Dates

The effects of the dispatching system where works are rushed to 100 per cent. capacity are worthy of special consideration. One great evil of rush times is the inability of manufacturers to quote deliveries intelligently. They accept an order for shipment months ahead, and on the agreed date the completion of the machine is more or less remote. The resulting controversy with a customer is always unpleasant. The trouble is that machinery builders often can only guess at production, which was demonstrated in numerous cases five years ago.

The Bullard dispatching system must obviate a great deal of this trouble. The department can lay out work for months ahead and come very close to the exact date of completion of each order. With a known producing capacity this is comparatively easy of accomplishment. When works are running at less than 100 per cent. a variation of capacity must be taken into account in determining the date of completion. This constitutes an unknown quantity, of course. But where this factor is assured, the date can be determined far in advance. The only change would be a possible earlier delivery, which would occur if capacity were increased beyond 100 per cent.; that is to say, if a night shift were put on and no effort made to increase the volume of product. If capacity were increased and if the volume of work going through were to be made larger, the dispatching system would tell accurately how much greater the volume could be made without disturbing deliveries. The company is master of the situation at all times because it knows the facts within very narrow limits.

THE BULLARD MACHINE TOOL CO. No. 3251
SPOILED OR DEFECTIVE MATERIAL REPORT.

Issued from Dept. Date 191

Job No. Piece No.
No. Pieces Name of Part
Rejected in Department
Cause
Time Foreman
THIS CARD MUST BE SENT TO SUPT.'S OFFICE AT ONCE WHEN FILLED OUT.
SPACES BELOW MUST NOT BE FILLED IN BY FOREMAN.
Disposition
Remarks
Charge to
Date Required Date Delivered
Approved Supt.

OPERATIONS COMPLETED			
Clean'g	Hard'ng		
Cut off	Polish'g		
Chuck'g	Grind'g		
Turning	Slotting		
Milling	Buffing		
Drilling	Gear Cut		
Bor Mill	Assem'g		
Hor Bor	Erect'g		
Plan'g			
Scrap'g			
Sc Mach.			
Forge			

The Spoiled or Defective Material Report

L. Vogelstein & Co., 42 Broadway, New York, furnish the following figures of German consumption of foreign copper for the 10 months ended with October, 1911:

	Tons.
Imports	157,934
Exports	7,507
Consumption	150,427

This compares with a consumption during the same period in 1910 of 141,472 tons. Of this quantity 138,991 tons was imported from the United States.

The Brinell Test for Automobile Steel

An Investigation Showing That Hardness as So Determined Gives No Dependable Measure of Strength or Other Properties

BY DENISON K. BULLENS*

The automobile industry has now become firmly established in the commercial world of to-day. Many of the smaller companies which sprang into existence with the first mushroom-like growth of the industry have fallen out of the race, due either to a lack of financial backing or to a poor car. The stronger and more reliable companies, having attained their stride and solved many of the mechanical difficulties, are now devoting a part of their energies to the standardization of parts and a study of the quality of the material used in the construction of the car. From the more recent efforts of the Society of Automobile Engineers we have a standard table of hardnesses for the testing of steel used in the construction of the car. In this article the author wishes to consider the application of the Brinell hardness test to the steel frames.

The two general methods of hardness testing in this country to-day are the Brinell test and the Shore scleroscope method. The former measures the resistance to indentation when the metal is stressed beyond the elastic limit by a concentrated load. The latter is based upon the rebound of a hard body from the surface to be tested. It is immaterial to this discussion whether we agree with Auchy or with Shore as to the exact qualities which the respective machines measure, as it is generally agreed that the Brinell hardness results are indicative, in general, of the static properties of the metal. But *is* the Brinell hardness test applicable to sheet steel as used in pressed steel automobile frames?

The Steel Tested and the Method

It is now generally recognized that the frame steel must be given a special heat treatment in order to relieve the strains set up in the rolling and later in the forming operation. This treatment, when exactly conducted, should

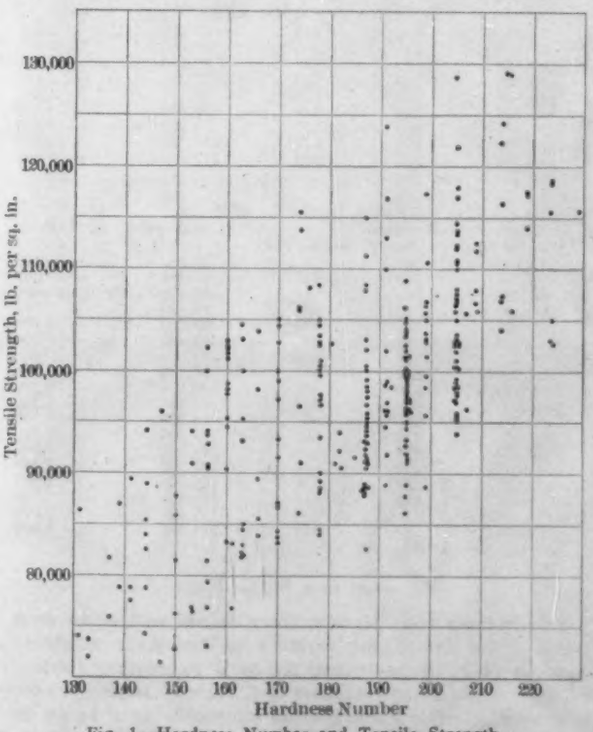


Fig. 1—Hardness Number and Tensile Strength

produce a finely crystalline, homogeneous structure, and bring out the maximum static and dynamic properties of the steel. It was upon such heat-treated stock that the following tests were made. The results are taken from some 3000 tests made during the past year in the laboratory of a leading automobile frame manufacturing company. They represent both experimental work and tests made on regular side bars. The material varied between ¼ in. and ¼

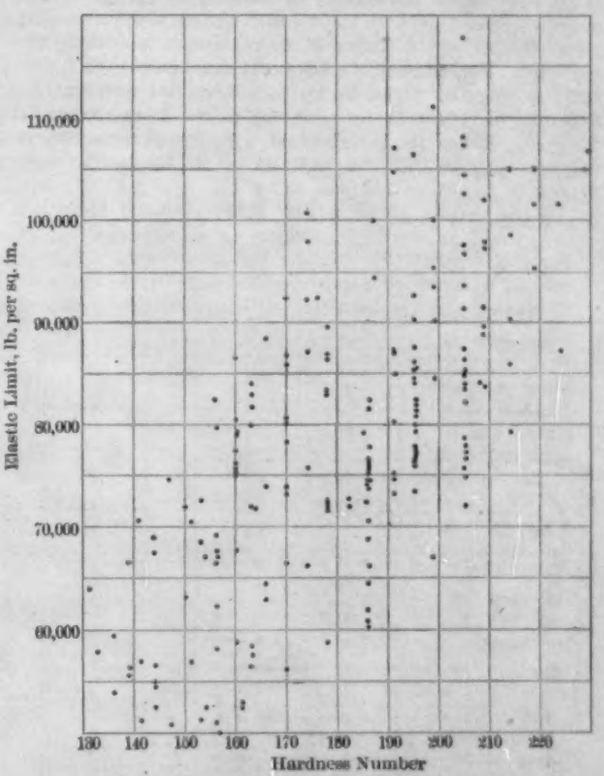


Fig. 2—Hardness Number and Elastic Limit

in. in thickness—a variance which had no effect upon the hardness results. The steel, as used in these tests, may be broadly classed as follows:

1. Chrome-nickel steel, hot rolled.
2. Chrome-nickel steel, cold rolled.
3. Special carbon steel, hot rolled.
4. Special carbon steel, cold rolled.

The physical tests were made with a 100,000-lb. Olsen automatic-autographic testing machine. The hardness results were obtained upon an Alpha-Brinell hardness machine, set for a pressure of 2830 kg. The diameter of the hardness impression was read with a specially constructed microscope and scale, by means of which a difference of 0.01 mm. could be readily estimated.

As much has been said about surface decarbonization a number of tests were made to determine if this actually took place. Readings were made upon the surface and upon the steel taken at depths (obtained by grinding away the surface) varying to 0.030 in. No difference whatever could be observed in these readings. The only precaution necessary was to see that there was no hardened oil upon the steel. In order to give a clean surface, however, the spot at which the hardness test was to be made was slightly polished. Microscopic investigation confirmed the above results, no skin or area of decarbonization being detected. The hardness tests were made upon the ends of the pieces used in the pulling tests, care being taken to get entirely away from the strained structure.

Hardness as Related to Other Physical Properties

Figs. 1, 2, 3, and 4 show graphically the relation of the hardness numbers to the tensile strength, elastic limit, per cent. elongation, and per cent. reduction of area of some 250 tests upon heat-treated, hot rolled, chrome-nickel steel.

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The last three plots show, as would be expected, no locus of points. There exists, of course, a varying relation between the elastic limit and the tensile strength, so that the plot shown in Fig. 2 will bear a certain relation to that of Fig. 1. This would also be true to some degree of the per cent. of elongation as shown in Fig. 3. But as the Brinell test strains the steel beyond the elastic limit it is not to be expected that a definite curve would result.

It is the relation of the hardness to the tensile strength, however, with which we are mainly concerned. According to general experimental work upon other steel we would expect some well-defined curve or locus. From Fig. 1 we can readily see that this is not the case with the sheet steel under discussion; no such locus exists. There is only a broad area or band which shows a difference of 30,000 lb. per sq. in. between the maximum and minimum readings. For example: a hardness number of 174 represents a range of 86,000 lb. up to 116,000 lb.; number 187, 83,000 lb. to 115,000 lb.; number 205, 94,000 lb. to 129,000 lb. Similarly, 86,000 lb. is represented by hardness numbers varying between 131 and 195; 94,000 lb. by 144 to 205; 103,000 lb. by 156 to 224, and so on.

All the results given in Fig. 1 are obtained from hot

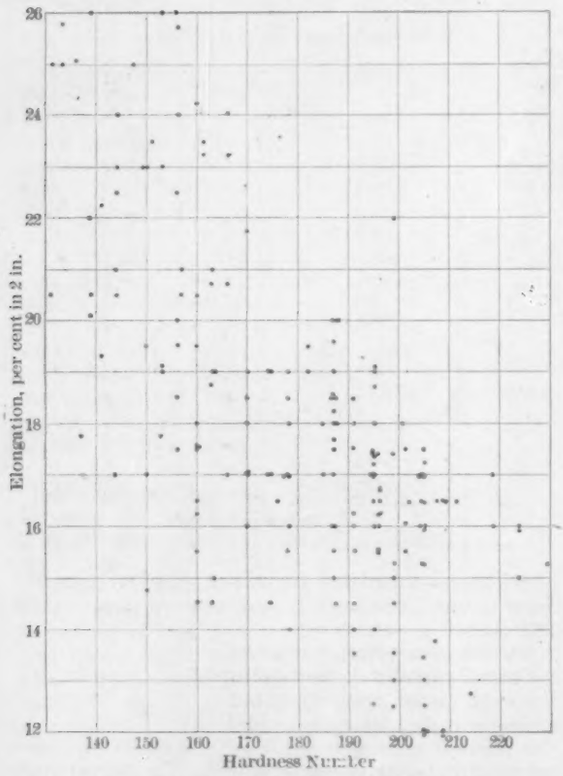


Fig. 3—Hardness Number and Elongation

rolled, chrome-nickel sheet steels of approximately the same chemical composition. The carbon will not show a variance of 10 points between the high and low values. The chromium and nickel are constant within limits of 20 points. The manganese values remain within 7 or 8 points. The phosphorus, sulphur and silicon are all low, so that they have no bearing upon the subject under discussion.

It was thought, however, that even these slight differences in chemical composition might possibly affect the steel as regards hardness. A series of tests was therefore made, using samples taken from the same part of the same heat, and rolled under exactly the same conditions. The chemical composition of each series of specimens was constant. It might also be stated that segregation was entirely absent in these high grade "quality" steels.

A Transference Number

In order to show the results obtained in a clearer light computations were made by which a "transference number" resulted. This number was obtained by dividing the tensile strength by the hardness number. An average transference number was found for each heat. By using this new result, and the hardness number of each test, a set of new, or computed, tensile strengths was obtained. The difference between the actual and computed tensile strengths should show the degree of accuracy of the hardness test. A comparison of the average transference numbers of the various heats should show the reliability of the hardness test as applied to steels of approximately the same chemical composition.

Tables 1, 2, 3, and 4 show the results obtained. The average transference numbers of the four lots of steel taken are 493, 549, 571 and 597, a difference of over 100 points between the first and last. With a hardness number of 200 this would result in a possible error of 20,000 lb. between the actual and computed tensile strengths. From experiments with numerous other heats of the same approximate chemical composition the author has found average transference numbers varying between 460 and 630. One can readily see where this will lead if that of any one heat, or even an average of several heats, is used.

TABLE 1.—STOCK SO. 933.

	T. S. Lb. Sq. In.	Hardness No.	Trans. No.	Computed T. S.	Diff. in T. S.
1.	82,900	163	508	80,400	— 2,500
2.	82,900	163	508	80,400	— 2,500
3.	84,200	170	495	83,800	— 400
4.	84,500	178	474	87,700	+ 3,200
5.	85,000	163	521	80,400	— 4,600
6.	86,100	174	495	85,800	— 300
7.	86,300	195	443	96,100	+10,200
8.	87,000	170	512	83,800	— 3,200
9.	88,400	178	496	87,700	— 700
10.	88,800	187	475	92,200	+ 6,600
11.	89,000	187	476	92,200	+ 6,800
12.	89,300	178	502	87,700	— 1,600
13.	90,000	178	505	87,700	— 2,300
14.	90,800	182	498	89,800	— 200
15.	91,300	187	488	92,200	+ 1,100
16.	91,800	195	471	96,100	+ 4,300
17.	92,600	187	495	92,200	— 400
18.	94,800	195	486	96,100	+ 1,300
19.	96,300	191	504	94,200	— 2,100
20.	97,200	178	546	87,700	— 500
21.	86,300	178	485	87,700	+ 1,400

Average Trans. No., 493.

TABLE 2.—STOCK 22,059.

	T. S. Lb. Sq. In.	Hardness No.	Trans. No.	Computed T. S.	Diff. in T. S.
1.	73,000	156	468	85,700	+12,700
2.	78,750	139	558	76,400	— 2,350
3.	78,750	144	540	79,100	+ 350
4.	78,800	139	560	76,400	— 2,400
5.	79,300	156	507	85,700	+ 6,400
6.	82,450	144	572	79,100	— 3,350
7.	86,600	141	635	77,500	—12,100

Average Trans. No., 549.

TABLE 3.—STOCK 6959.

1.	76,800	156	492	89,100	+12,300
2.	81,600	150	543	85,700	+ 4,100
3.	83,800	170	492	97,100	+13,300
4.	89,300	144	620	82,250	— 7,050
5.	90,500	156	579	89,100	— 1,400
6.	93,400	170	549	97,100	+ 3,700
7.	102,000	160	637	91,400	—10,600
8.	128,800	205	623	117,200	—11,600
9.	129,200	214	602	122,300	— 6,900

Average Trans. No. 571.

TABLE 4.—STOCK 5838.

	T. S. Lb. Sq. In.	Hardness No.	Trans. No.	Computed T. S.	Diff. in T. S.
1.	93,100	163	571	97,200	+ 4,100
2.	94,200	153	571	91,200	— 3,000
3.	94,200	182	517	108,800	+14,600
4.	94,500	160	590	95,400	+ 900
5.	95,100	163	583	97,200	+ 2,100
6.	95,200	168	595	95,400	+ 200
7.	98,200	166	591	99,000	+ 600
8.	100,000	163	613	97,200	— 2,800
9.	100,000	170	588	101,500	+ 1,500
10.	101,600	160	635	95,400	— 6,200
11.	102,300	156	656	93,200	— 9,100
12.	103,000	170	606	101,500	— 1,500
13.	104,700	170	616	101,500	— 3,200
14.	105,000	170	617	101,500	— 3,500
15.	105,000	178	590	106,300	+ 1,300
16.	108,000	174	619	104,000	— 4,000
17.	108,100	176	613	105,100	— 3,000
18.	108,500	187	579	111,800	+ 3,300

Average Trans. No., 597.

Variation in a Single Heat

Let us now consider the error found within the heat itself. Take the largest variance in each heat. Table 1 shows a range from —2500 lb. to +10,200 lb.; Table 2 from —12,100 lb. to +12,700 lb.; Table 3 from —11,600 lb. to +13,300 lb.; Table 4 from —9100 lb. to +14,600 lb. These show a possible error either way of 15,000 lb. between the computed and actual tensile strengths.

The tabulated results have been arranged according to ascending tensile strengths. The columns headed "Difference in Tensile Strengths" show no corresponding or regular arrangement of positive or negative errors according to the strength of the steel. The error is quite as likely to be a plus as a minus quantity.

What has been said of the hot rolled, chrome-nickel stock is also true of the cold rolled steel. The "contrariness" of the Brinell hardness test for this class—or thickness—of material is well shown by Table 5. The "A," or first set of tests, and the "B," or second series of tests, were made on the same lot of steel, the latter being made about a week after the former. The difference in the average transference numbers is 144 points. This would

TABLE 5.—STOCK CR. SO. 930.

	A.			B.	
	T. S.	Hard. No.	Trans. No.	T. S.	Hard. No.	Trans. No.
1.	122,900	205	598	81,000	205	395
2.	129,900	224	579	87,900	195	450
3.	131,000	224	584	88,500	187	473
4.	134,700	224	601	89,400	195	458
5.	137,000	214	640	92,700	195	474
6.	143,500	232	618	98,000	195	503
7.	.....	...	...	103,400	224	461
	Av. Trans. No., 603.			Av. Trans. No., 459.		

give an error of 42,600 lb. if the transference number of the first series had been used with (1) of the second series. This needs no further comment: it speaks for itself.

Results obtained upon hot and cold rolled special carbon steel are given in Tables 6 and 7. The hot rolled stock has shown a nearer approach to a dependable hardness and transference number than all the other steels tested. But even this steel has many exceptions and often gives incongruous results.

The Hardness Test in Practice

As an example of the application of the Brinell hardness test to the purchase of frames, take the following case: An automobile company purchases a large number of frames from the manufacturer, stating that certain limits of hardness must be observed. The frame-maker will probably use several heats of steel for the order. The data previously given in this article have shown that there exists a possible error of at least 20,000 lb. by using one general transference number or even an average of several, and to be added to this is another possible error of 15,000

TABLE 6.—STOCK 3HR.

	T. S. Lb. Sq. In.	Hardness No.	Trans. No.	Computed T. S.	Diff. in T. S.
1.	73,700	153	482	79,700	+ 6,000
2.	74,800	139	538	72,400	— 2,400
3.	75,800	160	473	83,350	+ 7,550
4.	77,000	153	503	79,700	+ 2,700
5.	77,200	163	474	84,900	+ 7,700
6.	82,000	163	503	84,900	+ 2,900
7.	82,000	174	471	90,650	+ 8,650
8.	83,500	163	512	84,900	+ 1,400
9.	87,600	178	492	92,750	+ 5,150
10.	88,500	163	543	84,900	— 3,600
11.	92,500	182	508	94,800	+ 2,300
12.	93,500	191	573	99,500	+ 6,000
13.	95,000	178	533	92,750	— 2,250
14.	95,500	182	524	94,800	— 700
15.	96,400	182	529	94,800	— 1,600
16.	97,300	182	533	94,800	— 2,500
17.	99,300	178	557	92,750	— 6,550
18.	104,300	199	524	103,700	— 600
19.	105,600	182	580	94,800	—10,800
20.	115,600	205	563	106,800	— 8,800

Average Trans. No., 521.

TABLE 7.—STOCK 3CR.

	T. S. Lb. Sq. In.	Hardness No.	Trans. No.	Computed T. S.	Diff in T. S.
1.	63,750	144	442	74,200	+10,450
2.	65,700	133	494	68,500	+ 2,800
3.	69,200	131	528	67,500	— 1,700
4.	72,800	150	485	77,300	+ 4,500
5.	74,000	131	565	67,500	— 6,500
6.	76,150	150	507	77,300	+ 1,150
7.	81,500	156	522	80,300	— 1,200
8.	84,800	174	487	89,600	+ 4,800
9.	93,300	187	498	96,300	+ 3,000
10.	93,700	195	498	100,500	+ 6,800
11.	94,000	174	540	89,600	— 4,400
12.	96,600	187	516	96,300	— 300
13.	109,700	174	630	89,600	—10,100

Average Trans. No., 515.

lb. from each heat in itself. This makes a possible cumulative error of 35,000 lb. The manufacturer heat-treats the steel according to a precise treatment worked out by the metallurgist. Under careful supervision, this treatment gives a side bar of uniform elastic limit, tensile strength and per cent. of elongation, with a minimum limit in each case. This is done regardless of hardness, as the manufacturer wishes to give his customer the best that is in the steel. The purchaser may refuse certain frames, stating that they do not fulfill hardness specifications. What is the result? The automobile company either accepts the word of the manufacturer that the frames are good, or else demands a re-treatment. If the frame is re-treated in order to make it answer to hardness specifications an inferior article usually results. It is a case of careful metallurgical work, with constant testing, as opposed to the uncertainty of the Brinell hardness test.

Practical examples of this condition of affairs have come to the author's attention. Frames under discussion have been cut apart and test pieces cut from them. In every instance the careful heat treatment has won out against the hardness test. In some instances it was found impossible to harden the steel sufficiently to reach a certain hardness number, and yet the steel showed up perfectly satisfactory when tested in the pulling machine. It has even been found that steel answering to the same chemical specifications, but purchased from different steel companies, would give largely variant Brinell hardness tests. Again, heats purchased from the same company, rolled from the same temperature after soaking, with the same number of passes and per cent. reduction but having a large variance in chemical composition, have been found to give approximately the same transference numbers.

Accounting for Variations

It is very difficult to explain the seeming contradictions which experience has shown. However, the large number of contributing causes might be broadly classed as follows: (1) Inherent; (2) mechanical; (3) structural.

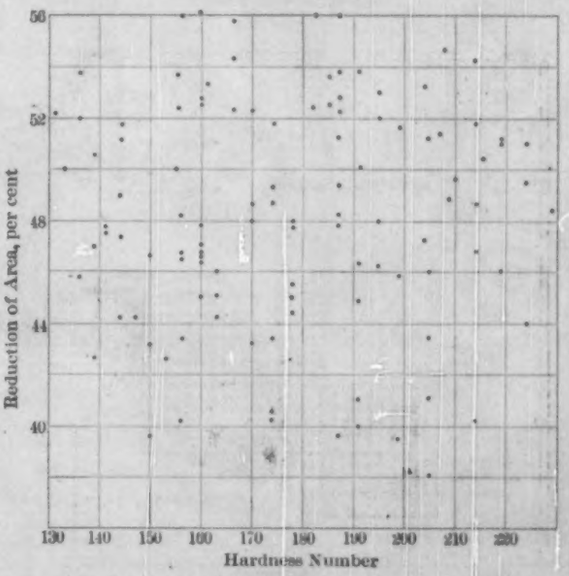


Fig. 4—Hardness Number and Production of Area

Inherent causes include the grade of the material used in the manufacture of the steel, and the chemical composition. Mechanical causes include the temperature and length of soaking, the rapidity of reduction, and care used in rolling. Structural causes may be divided into annealing and heat treatment, each influencing the actual condition and proportions of the various microscopic constituents of the steel.

The annealing may or may not remove all the effects of rolling and previous heating. The ordinary furnace anneal will simply give a soft steel. The effects of any overheating in the soaking operation or too rapid reduction in the rolls are not generally removed. This is due to the fact that a long and continued heating at the high temperature necessary would result in such a degree of oxidation of the finished steel sheets that they would be practically useless. Although these strains are generally relieved by the further heat treatment, a few of the worst sheets (structurally speaking) may still retain hard or soft spots which will influence the hardness test.

The general microscopic constituents of heat-treated, chrome-nickel steel frames are troostite, sorbite, martensite and pearlite. The troostite is generally the largest in amount, and the others in the order given. The predominant constituent will be determined, first, by the chemical composition of the steel, and, second, by the heat treatment necessary to give certain physical tests. In chrome-nickel steel the elements having the greatest influence upon the physical properties are carbon, chrome,

nickel, and manganese, in the order given. These also influence the recalescence point of the steel, which becomes a very important factor in the correct quenching temperature. With all these variables introduced, and with standard physical specifications in view, there will necessarily result varying proportions of the microscopic constituents. And as these constituents have each a different hardness the complexity of the problem is readily recognized.

The Brinell hardness test as applied to the purchase or sale of heat-treated, sheet steel automobile frames is not dependable. It is an excellent supplementary aid to laboratory work, but it necessitates a thorough knowledge of the steel in question and constant bearing in mind that the test is only generally approximate and far from infallible.

The American Brass Company

With the opening of the new year the American Brass Company, Waterbury, Conn., becomes an operating company instead of a holding company as heretofore. Its subsidiaries, the Ansonia Brass & Copper Company, Benedict & Burnham Mfg. Company, Coe Brass Mfg. Company, and Waterbury Brass Company, become branches known by the names of the old corporations. Each branch will have its own accounts, as the companies do now, but checks will be drawn to and by the American Brass Company.

Besides the corporations that are thus extinguished, the American Brass Company controls the Chicago Brass Company, Kenosha, Wis., the Waterbury Brass Goods Corporation, and the Ansonia Land & Water Power Company. They are owned by the present subsidiaries, and under the new régime they will become the property of the American Brass Company through stock ownership. They may eventually be consolidated with it, as their parent companies are about to be, but that step has not yet been reached. Holmes, Booth & Hayden, another Waterbury brass house, was merged with the Benedict & Burnham Company some time ago and now becomes merged with the main corporation.

The American Brass Company was incorporated in Connecticut in 1903 to hold the stock of the four principal constituent companies. The brass industry had long centred in the Naugatuck Valley, and the stock of the four companies was largely in the same hands. Large owners in one company were large owners in the others. The stock was also closely held, and the few families that were dominant in the industry in Waterbury, Ansonia, and surrounding towns decided to amalgamate their interests with a view to simplicity and economy in production.

Consequently, at the formation of the American Brass Company, it acquired not only the control but the entire capital stock of the constituent corporations. It was first capitalized at $15,000,000, but this has twice been increased by $2,500,000, so that the present capitalization is $20,000,000. Of this, however, only $15,000,000 has been issued. Most of the other companies in the merger were taken in soon after its formation, and the recent policy of the directors has been not to increase their percentage of control over the brass industry.

The present plan was authorized by the directors, who are also the principal stockholders, under authority vested in them by the by-laws. The annual meetings of the constituent companies take place on the first Tuesday in February. The American Brass Company is the only stockholder, and it is expected that measures will be taken at that time for the final dissolution of the several corporations.

The new arrangement will make no change in the chief officers of the American Brass Company, which will remain as follows: President, Charles F. Brooker; vice-presidents, Edward L. Frisbie, A. A. Cowles, and James S. Elton; treasurer, John P. Elton; secretary, Gordon W. Burnham. The other directors are Thomas B. Kent, J. E. Wayland, E. Holbrook, Arthur C. James, John J. Sinclair, Cleveland H. Dodge, James A. Doughty, Adelbert P. Hine, and T. Brownell Burnham. Besides the three vice-presidents elected by the board the organization of the company provides for several appointive vice-presidents, and it is expected that some of the officers of the constituent companies will be named for these places.

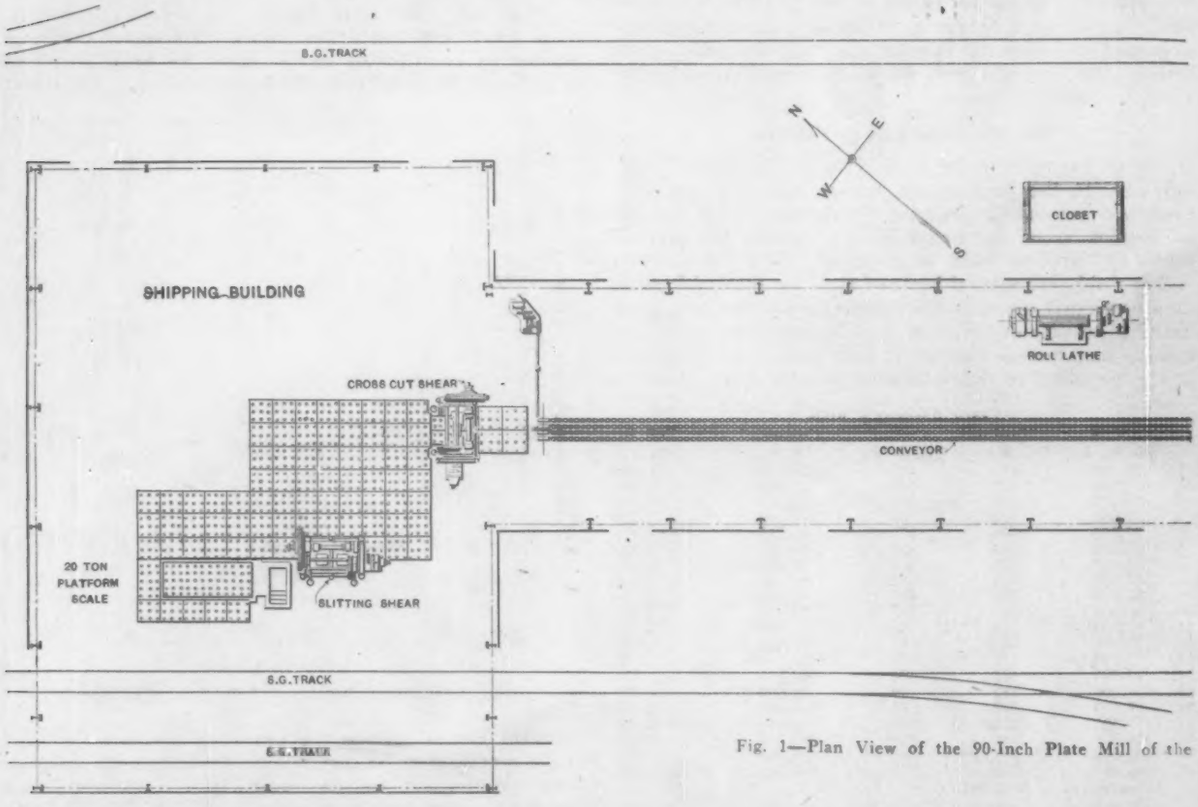


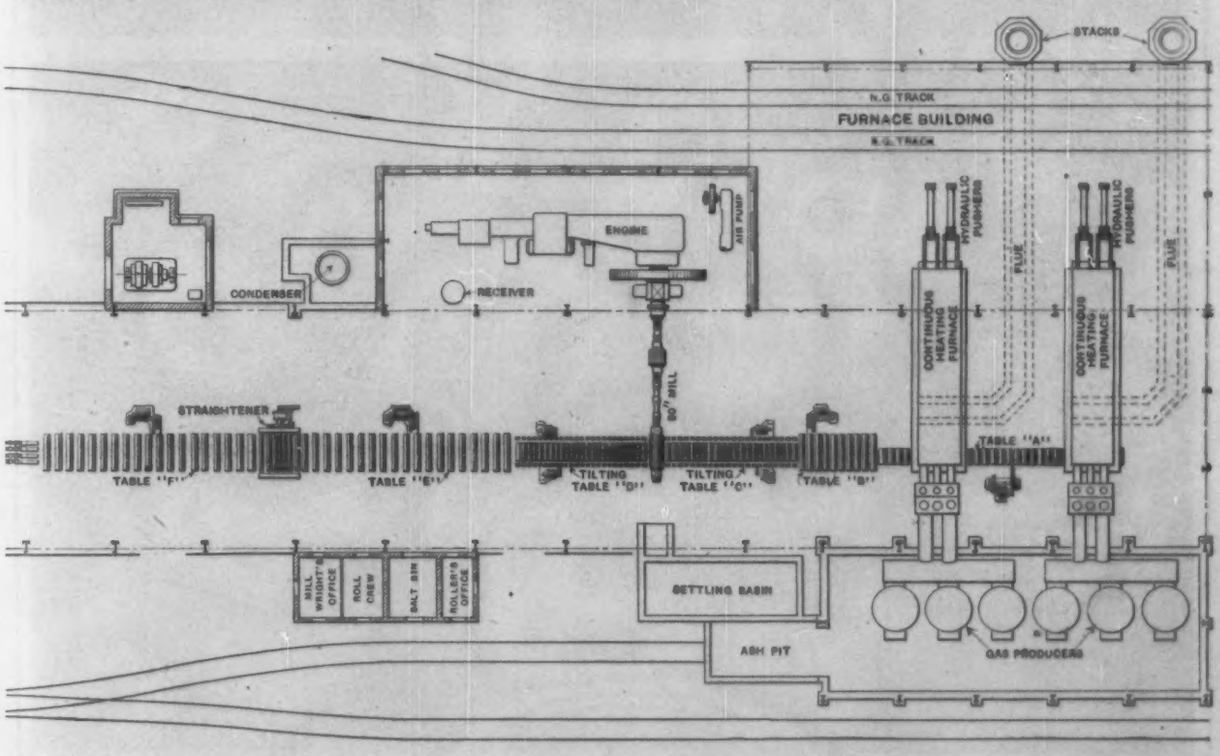
Fig. 1—Plan View of the 90-Inch Plate Mill of the

In the opinion of Chairman James J. Hill of the Great Northern Railway Company, the opening of the Panama Canal will play a very small part in changing either the nature or amount of the business of the railroads running to the Pacific coast. Practically everything used on the coast can be bought no further east than St. Louis or Chicago to as good advantage as it can be obtained on the Atlantic seaboard, and the Northwest will find it cheaper to continue moving its business by rail and in a direct line. He thinks there is very little eastbound business likewise that the canal can take from the railroads.

Plate and Merchant Mills at Haselton, Ohio

New Finishing Plant of the Republic Iron & Steel Company in Connection with Its Open Hearth Steel and Wrought Pipe Works

A description of the new open hearth plant of the Republic Iron & Steel Company at Haselton, Ohio, was given in *The Iron Age* of August 17, 1911. Reference was made therein to the plate and merchant mills, which were at that time under construction. The location of these mills was shown on the general plan of the entire plant. The present article is concerned with details of the two mills. The plate mill was built primarily to complete the company's facilities for making all of its own skelp for its new tube works. It also greatly increased the range of plate sizes which the company sells in the market, starting as it does with skelp 25 in. wide and rolling plates up to 84 in. wide.



Republic Iron & Steel Company at Haselton, Ohio

The mill is three-high and is driven by a 34-in. and 60-in. x 60-in. horizontal tandem compound engine of approximately 2500 hp. at 80 r.p.m. There are two gravity heating furnaces, as shown on the plan in Fig. 1, the charging ends of which are served by an overhead crane equipped with a magnet for handling slabs. Space has been reserved for an additional furnace of the same type or for two Siemens furnaces should the demand upon the mill warrant their installation. Gas is supplied by the three gas producers for each furnace.

The Plate Mill and Tables

The plate mill and tables, which were designed and built by the United Engineering & Foundry Company, are of the usual type but embody a number of features which are somewhat unusual. The roll housings of the mill are cast steel. The rolls are 90 in. long, the top and bottom rolls 32 in. diameter and the middle roll 22 in. diameter. The top roll is counterbalanced by weights, the balance levers being carried on the housings, and connected to balance rods by links, which keep the rods in contact with circular segments on the levers, thus compelling the rods to move vertically and preventing their bending. The middle roll is raised by hydraulic cylinders on the side of the housings, which are connected to the roll by balance arms, these latter being connected by rock shafts and levers for equalizing the lift.

The screw down is operated by a 37½-hp. Westinghouse mill type motor, with slip gear and magnetic brake, through worms and wheels which are entirely enclosed and run in oil. The entire screw down mechanism is carried on a steel casting, extending from housing to housing, which forms the bearings for the worms and wheels and carries the motors. This mechanism can be removed by attaching crane chains to four eye bolts.

The intermediate and vibrating spindles are 10 ft. long, provided with spindle carriers of the usual design. The pinions are cast steel, the top and bottom being 34 in. diameter and the middle 22 in. diameter by about 40 in. face. The engine shaft is connected to the middle pinion. Pinion housings are cast steel, of the enclosed type, cast in two pieces connected by heavy flanges and bolts.

The tilting tables are 28 ft. long, center to center of end rollers, having side shafts driving alternate rollers. The table rollers are 13 in. diameter x 4 ft. long, with shafts cast in, having disks of the same diameter as the rollers, outside of bearings, as is usual on plate-mill tables. Each table is operated by two 37½-hp. Westinghouse mill type motors, connected to the table through countershafts. The motors are arranged to run in series, and are equalized by having one roller in each table geared to both line shafts. The table is pivoted on a segmental shoe, resting on babbitted bearing in the pivot base, and thus an exceedingly large bearing surface is secured. This shoe also forms a separator for the table girders, and means for carrying the motors, which are located at the point of suspension, and consequently have very slight motion. The raising and lowering of the tables is by hydraulic cylinders operating through levers, with weight counterbalance. The lifting rig is made with very large pins and links, designed to keep the bearing pressure very low, thus keeping down wear.

Two 110-in. plate shears are provided for the regular shearing equipment and a circle cutting shear for circular plates. The building is of all-steel construction and overhead cranes cover all machinery. Figs. 2 and 3 are views

Fig. 2—Shears in 90-in. Plate Mill
Fig. 3—View of Plate Mill from Furnace Side
Fig. 4—Plate Mill from Delivery Side

Fig. 5—Cooling Beds in 16-14-in Merchant Mill
Fig. 6—View of Merchant Mill from Producer Platform
Fig. 7—Merchant Mill, from Finishing End

of the plate mill from opposite sides and Fig. 4 shows the shears and the provision for the manipulation of the plates to be sheared.

The 16-In. Merchant Mill

This mill was built for the purpose of providing for the company's increasing demands for merchant shapes and is designed to roll rounds from 1 in. up to and including 3½ in. in diameter and equivalent weights of ovals, squares, etc., flats up to 12 in. in width, angles up to 5 x 5 in., and I beams, channels, etc. of equivalent section. Figs 5, 6 and 7 give views of the merchant mills and of the cooling bed.

There are two gravity discharge heating furnaces and space has been reserved for an additional furnace should it become necessary. The charging ends of the furnaces are served by an electric overhead traveling crane for handling the billets and slabs from the transfer cars directly to the furnaces. These furnaces are 13 ft. wide and are designed to take billets up to 6 in. x 6 in. x 12 ft. and slabs up to 12 in. in width. The two furnaces give the mill a possible output of 12,000 tons a month. Gas for the heating furnaces is supplied by six Morgan gas producers, located close to the delivery end of the furnaces and provided with automatic feeds. The billets are mechanically pushed through the furnaces and delivered on the roll table leading to the roughing mill. They pass under scaling rolls and through a hydraulic shear for cutting the long billet into two or more pieces of the weight desired for finishing.

The mill consists of eight stands of 16-in. rolls in tandem, in which all the larger sizes can be finished and delivered directly to the cooling bed; also three stands of 14-in. rolls for the smaller sizes. It is so arranged that the material can be diverted to the 14-in. rolls after passing through either the sixth or seventh stand of 16-in. rolls, thereby permitting the changing of the finishing rolls of the 16-in. mill while rolling sizes which can be finished in the 14-in. mill.

The entire mill is driven by a 36-in. and 66-in. x 60-in. horizontal cross compound Corliss engine with a speed range of 45 to 80 r.p.m. A double cooling bed is provided with a total length of 160 ft., so arranged that a single row of the smaller sizes can be handled in lengths up to 160 ft. or a double row of the larger sizes in lengths up to 80 ft. The cooling bed is of the Edwards oscillating, saw tooth type. The finished sections are received on a motor driven, hot runout table. They are picked up and slid sidewise by rocking the trough sections of the conveyor. They are then worked broadside across the bed by oscillating the racks. Beyond the racks is a creeping bar assembling table, which delivers any desired number of bars to the cold runout table, and the latter delivers the cooled material to the shears, unsymmetrical sections that camber in cooling being passed through intermediate straightening rolls. The George patented shears are of all-steel construction and are adapted to shear a large number of bars at once. The length is accurately determined by means of a back shear table, gauge bar and adjustable stop. The Morgan Construction Company, of Worcester, Mass., did all the engineering and designing and furnished the complete equipment excepting the building and engine. The main building is 825 ft. long, 115 ft. span of building column and contains two 15-ton electric overhead traveling cranes, one of which is intended for general service, and the other for loading material.

For both the plate mill and merchant mill engines, steam is provided by the main battery of boilers at the open hearth plant. The tables, shears, straighteners, etc., in both mills are electrically driven, power being supplied from the blast furnace plant.

Iron and Steel Making in Texas

With Convict Labor Blast Furnace Operation Has Not Been Successful.—Quality and Availability of East Texas and Llano County Ores

BY WILLIAM B. PHILLIPS*

During the last two years there has been a revival of interest in the iron ores of east and northeast Texas. Not a few of the more prominent newspapers and some of the technical journals have published articles on the subject and many inquiries have been set on foot.

There are now three companies engaged in the prosecution of plans for developing these ores on a commercial scale, but it is not understood that any one of them is contemplating the smelting of ore either in Texas or elsewhere in the Southwest. Such plans as have come into public notice look towards the shipping of Texas ores from Gulf ports, including Galveston, Texas City and Port Bolivar, to Baltimore, Philadelphia and other points along the Atlantic Coast and possibly to England and continental Europe.

Iron and Steel Consumption in Texas

Reports have been made on the possibility of assembling these ores on the Gulf and erecting there blast furnaces and steel works. These plans, tentative and somewhat inchoate, considered the bringing of coking coal from Alabama and West Virginia and the construction of by-product ovens at a point so convenient to Galveston or Houston, or other city as to admit of the sale of the surplus gas, for example, for power and heating purposes. It was pointed out that not only would there be a ready sale for such gas, but that the concurrent manufacture of tar, light oils, pitch and sulphate of ammonia would add sources of revenue of no mean sort, to say nothing of the manufacture of cement from the blast furnace slag or of phosphatic material from the basic open-hearth steel furnaces. While it may not be doubted that a considerable and a lucrative business could be secured by shipping these ores to coastwise or to foreign furnaces, yet we are of the opinion that a much better and a more permanent business could be built up in the production of pig iron and steel in the State of Texas.

The consumption of pig iron as such in Texas is now between 250 and 300 tons a day, inclusive of all grades. This iron comes from Alabama, Colorado, Ohio, Pennsylvania and elsewhere, and is taken by the different foundries now in operation. In addition, there is a very large consumption of rolled iron and steel in manifold forms, the exact statistics of which it is impossible to gather. In cotton ties, wire fencing, wire nails, material for reinforced concrete structures, etc., there is, beyond any question, a very large and an ever widening market in Texas and the Southwest generally. By far the greater quantity of such material is hauled from 500 to 1000 miles before it reaches the borders of Texas and then has an additional haul of 250 to 500 miles before it reaches its chief points of consumption within the State.

The saving in freights alone would add a considerable item to the gross revenues of an iron and steel plant operating within the State. The lowest rate from the ore fields to tide-water may be taken at $1.34 a ton, the maximum distance being something over 300 miles.

Character and Supply of Texas Ore

Three or four years ago some 2200 tons of east Texas iron ore was sent to the Birmingham district, Alabama, a distance of 500 miles, the all-rail rate being $2.20. But this business has been discontinued and no such shipments have been made since 1907-1908.

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Up to this time there has been one experimental shipment made to Philadelphia, by way of Texas City, on Galveston Bay. This comprised 568 tons, and the railroad haul was about 300 miles. The average content of the ore sent to Alabama and to Philadelphia was a trifle over 57 per cent metallic iron, with phosphorus ranging from 0.10 to 0.20 per cent. The ore was excellently well adapted for the production of basic open-hearth stock. While it may not be possible to secure large and regular shipments of 57 per cent. ore from east Texas yet we believe there are very large supplies of 50 per cent. ore which can be mined and loaded for 85 cents to $1 a ton. Such ore could be laid down in the stockyard of a furnace at Jefferson for $1.25 a ton and at Texarkana for $1.50 a ton. The ore cost of a ton of pig iron should not exceed $3 at either of these localities.

The results of careful investigations into the extent of these ore fields and the amount and quality of the ore to be obtained have changed the situation radically. One company alone has dug more than 800 pits on but a small part of its holdings and has proved the extent and quality of the ore in areas that were previously not regarded as within commercial considerations. The writer has inspected nearly 300 of these pits and speaks from personal knowledge. We may dismiss, as unworthy of further discussion, questions of ore supply and quality. There are very large reserves of iron ore in east Texas that will carry 50 per cent. of iron, with less than 0.25 per cent. of phosphorus. What can be done with this ore?

Texas Furnaces Not Successful

The attempts that have been made up to this time to manufacture pig iron in Texas have all resulted disastrously. The last furnace to close down was the State furnace, at Rusk, Cherokee County, which was shut down in 1909 and has been and is still for sale or lease. There is not a single iron furnace in operation within the State. Various reasons may be and have been assigned for the failure of the iron business in Texas. It is not our purpose to inquire into any of them at this time, although the satisfying nature of many of them lies almost upon the surface. What is past is past and we profit by it only as a guide to the future.

We may dismiss for the present the matter of building iron and steel works on the Gulf coast. The enterprise would involve very large expenditures and these, with our present lights, can hardly be commended. Especially would this be the case if by-product ovens should be constructed. Unless all of the by-products can be profitably marketed such ovens pay but little on the investment. There must be a ready sale, or compensating use, for the surplus gas, the tar and the ammoniacal liquor. All of the coke and, perhaps, all of the gas would be taken by the blast furnace on the one hand and the steel works on the other. We may allow that the tar, find a partial market, but it would meet with considerable competition from the asphalt derived from the refining of Texas and Oklahoma crude petroleum in local works. The local market for sulphate of ammonia is limited and this would have to be shipped out. In this connection, however, it is to be mentioned that two fertilizer plants are to be built near Houston and these would afford a near-by market for sulphate of ammonia. The consumption of commercial fertilizers in Texas is increasing rapidly and is now about 55,000 tons as against about 35,000 tons last year.

The Practicable Iron and Steel Plant

But iron and steel works of the size to make profitable use of by-product ovens are not now needed in Texas or the Southwest. Instead, it seems to us that a blast furnace plant producing 250 to 300 tons of pig iron a day with a steel plant whose product would enter into the lighter finished forms, is much more to the point. The initial investment would be much less and the character of the product could be kept in closer touch with actual demands. The logical location for such a plant would be in east or northeast Texas, in close proximity to the ore fields and within reach of the coking coal of Oklahoma and Arkansas. So far as known, there is no good coking coal in Texas and the nearer an iron furnace is to regular supplies of coke the better. Coking coal or coke will have to be brought in from some other State.

Cost of Making Coke Pig Iron

We do not here consider the making of charcoal iron, for the reason that it would cost a good deal more than coke iron and would have a more restricted market. From Jefferson, Texas, to the coking coal fields of Oklahoma, the distance is 275 to 300 miles, and it is 200 miles to the coking coal in Arkansas. From Texarkana, Texas, to these fields is 50 miles less. It is probable that a fair blast furnace coke could be laid down at Texarkana or at Jefferson for $5 to $5.50 a ton. We may allow that a ton of this coke would smelt a ton of pig iron, for the east Texas ores are easily reduced. The fuel cost per ton of iron should not exceed $5. The total fuel, stone and ore cost per ton of iron should not exceed $8.50. If we allow $2.50 a ton for all other expenses—a figure which should be well within the mark—we come to $11 a ton as the total cost of making basic open-hearth stock in northeast Texas. With such iron quoted in the Birmingham district at $10 a ton there would seem to be a fair margin of profit.

The most favorable outlook in Texas and the Southwest, for the manufacture of iron and steel is in the direction of a blast furnace with auxiliary steel plant, not operated so much with reference to the demand for the heavier forms, as structural shapes, plates or rails, as to the demand for cotton ties, wire fencing, wire nails, perforated metal, pipe, light steel castings, etc. That such an enterprise would succeed here, under proper management, is, we think, well within the bounds of probability.

Some Results of Experience

As contrary to the above view, in some particulars, we will quote from a recent letter from a practical iron man who has had experience in smelting the east Texas ores. He says:

"In a small way the iron industry in Texas can be made a very paying proposition, if all of the product be put into castings, such as water and gas pipe, drain and culvert pipe, house and store fronts—in fact all manner of castings. In a small way in Texas an open hearth plant might be advantageous, using oil as fuel. On a large scale I do not think that iron production in Texas will ever amount to anything, unless some means be taken to develop the Llano country ores and get in cheap fuel. * * * I used charcoal which I produced for 3½ cents per bushel, turning the kilns over every 20 days. But this can be bettered very much, as, at Sligo, Mo., in the same type of kilns, using free labor, the kilns are turned over every 12 days, producing the charcoal at 3½ cents per bushel.

"I do not think that the wood supply of east Texas, within such a radius of the furnace as to warrant cutting timber for coaling, is great enough. Coke would, therefore, have to be supplied at such figure as to warrant its use. The ore that I mined came from Cherokee County, near Rusk. It could be mined and delivered at the furnace for an actual cost of 45 cents a ton. This is a laminated ore, blanket formation, capping the high ground and overlaid with sand to a depth of from 2 to 6 ft. Wheel scrapers were used for stripping off the sand. The ore was then blasted out with black powder, the average thickness being 18 in. The analysis of the ore was about as follows:

Iron	46	to 48	per cent
Silica	10	to 14	per cent
Phosphorus	0.25	to 0.28	per cent

"About 2.2 tons was required for a ton of pig. The consumption of charcoal averaged 108 bushels per ton of pig and of limestone from 450 to 500 lb. per ton of pig. The cost of the limestone was $2.10 a ton."

Low Costs Due to Convict Labor

Taking these figures we find that the stockhouse cost of a ton of pig iron for raw materials was as follows:

2.2 tons of ore @ 45c.	$0.99
108 bushels of charcoal @ 3½c.	3.78
500 lb. of limestone @ $2.10.	0.52
	$5.29

This would appear to be a very low cost for the raw materials entering into a ton of charcoal iron. A partial explanation may lie in the fact that the labor used in mining the ore and in making the charcoal was convict labor belonging to the State and not leased. Be that as it may,

we do not think that any such costs could be reached with free labor. For the production of charcoal iron in east Texas we are inclined to think that, with free labor, the cost of raw materials would be about as follows:

2.2 tons of ore @ $1.25	$2.75
100 bushels of charcoal @ 6c	6.00
500 lb. of limestone @ $2.10	0.52
	$9.27

or 77 cents a ton more than for coke iron.

With respect to charcoal: The point raised by our correspondent that there is not a sufficient supply of coaling timber within a working radius appears to be well taken. It is likely that on account of comparatively long hauls very little charcoal could be secured under 6 cents a bushel and most of this would be hard wood coal. There is still a good stand of such wood in many parts of east Texas, but it would be difficult to secure large holdings within a working radius of a furnace. This consideration would also affect the building and operation of by-product charcoal kilns.

The Llano County Ores

In regard to the Llano county iron ores to which our correspondent refers: Some of these ores carry from 60 to 65 per cent. of iron, and in certain localities the phosphorus is low enough for the production of Bessemer stock. They occur at about the same distance from tidewater as the more northerly of the east Texas ores, i.e., about 300 miles, and would probably carry the same freight rate. It is to be observed here that the Texas Railroad Commission, whose jurisdiction extends over such matters, has not yet established a maximum rate on intrastate iron ore shipments, so that estimates of the cost of railroad transportation are subject to correction. The $2.20 rate for the haul to the Birmingham district, 500 miles, was inter-state business and as a matter of fact the haul within the state of Texas did not exceed 50 miles. What the rate will be for business originating in and confined to Texas no one knows. When the case is brought before the Texas Railroad Commission, large and regular shipments being involved, a decision will doubtless be rendered. For the most part the Llano county ores are close-grained, hard and dense magnetites and hematites whose reducibility in the furnace is not to be compared with that of the more or less spongy east Texas ores. With the exception of one mine, which has been full of water for many years, there is no known commercial deposit of iron ore in Llano county that is within 12 miles of a railroad.

In time these ores may come into the market, but for the present the chief interest centers around the east Texas ores. In quality some of these ores are excellent; e.g., from the old Olive mine, from the Iron Mountain, Bader tract, etc., in so far as concerns the results of careful hand sampling. Just what grade of ore could be shipped under specifications remains to be seen. The phosphorus varies so much, in many excellent samples being much above the Bessemer limit, that shipments would have to be carefully sampled, if the ore should be marketed as Bessemer ore. If not intended for such purpose the ore would have little or no advantage over east Texas ore. It might be higher in iron but the smelting costs would counterbalance this advantage. The most costly single item in iron making is coke and a saving in fuel soon becomes evident.

Peat Deposits in the United States

The results of an investigation that was undertaken to determine whether peat, a fuel widely used in some countries, could be serviceable in the United States are contained in a bulletin, "The Uses of Peat for Fuel and Other Purposes," just published by the Federal Bureau of Mines. The author of the bulletin, Charles A. Davis, the peat expert of the bureau, gives an exhaustive review of the problem, both in this country and in Europe, and draws the conclusion that the peat beds of this country are a great and neglected resource, which, when properly and fully developed, will add to our national wealth no inconsiderable quantity of good fuel and of raw material for important arts and manufactures.

He tells frankly about the good and bad of peat. He declares that the difficulties that have always been encountered in utilizing peat for fuel are due to the fact that in its natural state peat contains only about 10 per cent. of combustible matter, the remaining 90 per cent., more or less, being water. He also says that in the last few years more than $1,000,000 has been spent in erecting plants and in experimenting with peat, and that these efforts were unsuccessful, but he adds that because the closing of larger plants before they had reached a stage of demonstrated success was so general, more conservative developments have been planned for making a thorough trial of the material in favorably situated places under American conditions of production and fuel supply.

Mr. Davis estimates that there are more than 11,000 square miles of land in the United States having peat deposits of good quality. He declares that in these deposits there are 12,888,500,000 tons of peat with a value of more than $38,000,000,000, being enough to furnish heat and power for the entire country for many years. While he is of the opinion that there will soon be a demand for peat as a fuel, he gives the following warning: "The foundation of all successful development and growth of peat industries in the United States must be a thorough scientific study of the occurrence, nature, qualities and peculiarities of peat itself and a careful and honest investigation of the status of these industries in the European countries in which they have reached self-supporting existence. To begin without these preliminary studies would be the height of folly."

Gas Poisoning Among Iron and Steel Workers

The commission which was appointed by the Illinois Legislature in 1907 to study occupational diseases in the industries of the State and which recently rendered its report, has made an instructive although inconclusive investigation into carbon monoxide poisoning among iron and steel workers. The inquiry was limited to five large plants in South Chicago and Joliet.

Among 900 employees of blast furnaces investigated by the commission, it was found that there had been 65 severe and 216 mild cases of gas poisoning in the past year and 13 fatal cases in the past four years. Among 212 employees of boiler houses it was also ascertained that there had been 1 severe, 55 mild, and 1 fatal case of gas poisoning. It was also pointed out by the commission that even in mild cases of gas poisoning there was a danger of the men becoming unconscious or failing with serious or fatal results, sometimes from a hight, sometimes against hot furnaces or metals, or into other dangerous positions.

It was also found by the commission that in the past 20 years there had been a marked decrease in the number of cases of carbon monoxide poisoning in the Illinois Steel Works. This favorable condition of affairs has been brought about by the introduction of safer furnaces and methods of conveying gas, by taking measures to keep employees out of dangerous places, by the use of oxygen helmets among those employed in hazardous places where they are frequently exposed to the gas, and by the education of the employees to the dangers through printed or oral instructions. The commission recommends that similar precautions should be taken in all steel mills of the State.

Coal exports from the United States have trebled in value in the last dozen years. The value of coal passing out of continental United States in the year 1911 is, in round terms, $80,000,000, compared with $65,000,000 in the preceding year. The stated value of coal exported in the 10 months ending with October, 1911, is $44,000,000, that of coke $3,000,000, and that of coal supplied to vessels engaged in the foreign trade $18,000,000, making a total of $65,000,000, and justifying the Bureau of Statistics of the Department of Commerce and Labor in its foregoing statement.

At an official test of agricultural motors recently held by the authorities of the province of Buenos Aires, Argentina, the Ororu motor, made by Holt & Co., San Francisco, Cal., manufacturers of the Caterpillar engine, was awarded the competitive prize. Several entries had been made by foreign firms, but before the contest took place all withdrew except Holt & Co. The authorities decided, however, to put the American motor through the various tests, and it so completely satisfied all requirements that it was awarded the prize.

Power Requirements of Rolling Mills

Apparatus for Ascertaining the Relation between Heavily Imposed Loads and Limited Speed Variations together with Economical Operation of the Prime Mover

BY SAMUEL S. ROBERTS*

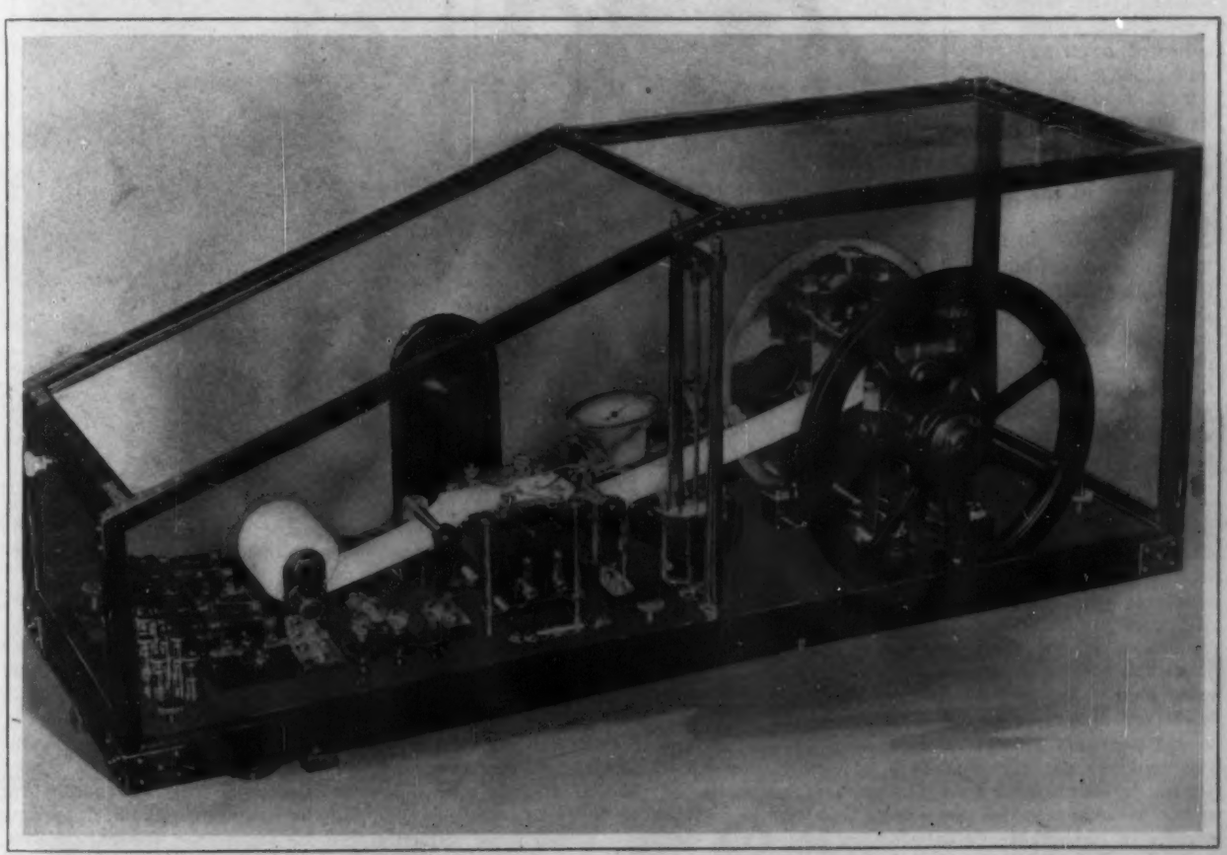
(With Two Supplemental Plates)

The first part of the following article deals with the practical importance of a graphical analysis of the power measurements, with corresponding speed determinations of the rolling mill; the salient features of the equipment requisite for rolling mill application, eliminating the human element and materially reducing the consequent number of operators necessary to man tests.

A systematic and comprehensive investigation of the numerous variables contingent to energy measurements of rolling mill operation is rendered problematical, else open to criticism, perhaps in nearly all cases, due to the inadequacy of the apparatus applied or to the course adopted at the discretion of the engineer in charge when conducting the field trials.

Familiarity with the phenomena of motor and flywheel effect demands, as an invaluable adjunct, an autographic appliance, electrically interlinked with the roll curves inherent to rolled sections. Such an instrument, in conjunction with continuous indicators, furnishes a reliable method of procedure in the field, which is always lacking when "guessometers" are employed—dependent largely upon the dexterity of the observers. An attempt to strike a balance sheet of the figures collected from the latter source calls for more or less juggling, in order to make the results appear rational.

Since an intelligent comparison of the data collated from different mills, even when rolling the same section,



Instrument Recording on a Paper Strip the Revolutions of the Mill Engine, the Elapsed Time by Half Seconds, the Length of Pass, the Instantaneous Fluctuation of Engine Speed and an Identification Line to Locate the Corresponding Steam Engine Indicator Cards

train, to insure instantaneous positive action, combined with dependence, since any momentary hesitancy due to inertia of the moving parts or lag of the electro devices would prove fatal to an authentic record of the investigation. Furthermore, the instrument should be capable of recording the events in their logical sequence throughout the entire mill cycle, thus rendering the system immune to the discrepancies which are likely to arise when personal observations are solely relied upon to report the rapid-fire fluctuations occurring during the rolling processes.

With these essentials in mind, the writer recently designed a tachographic instrument qualified to register automatically the data necessary to plot the irregular load

is often perplexing, owing to the diversified methods pursued by different experimenters, the purpose of this article, therefore, is to propose a standard, perhaps more scientific, way—applicable to the energy determinations at each instant, for the rolling of all classes of steel product—whereby the compilation of the results sought is facilitated and presented upon a uniform basis, at once apparent for interpolation.

In order to elucidate fully the susceptibility of the apparatus to quick and minute load changes, the test selected for demonstration covers a tandem-compound unit, fitted with a sensitive shaft governor driving a single stand of three high rolls, served with quick acting mill tables, the fractions-of-second periods elapsing during the

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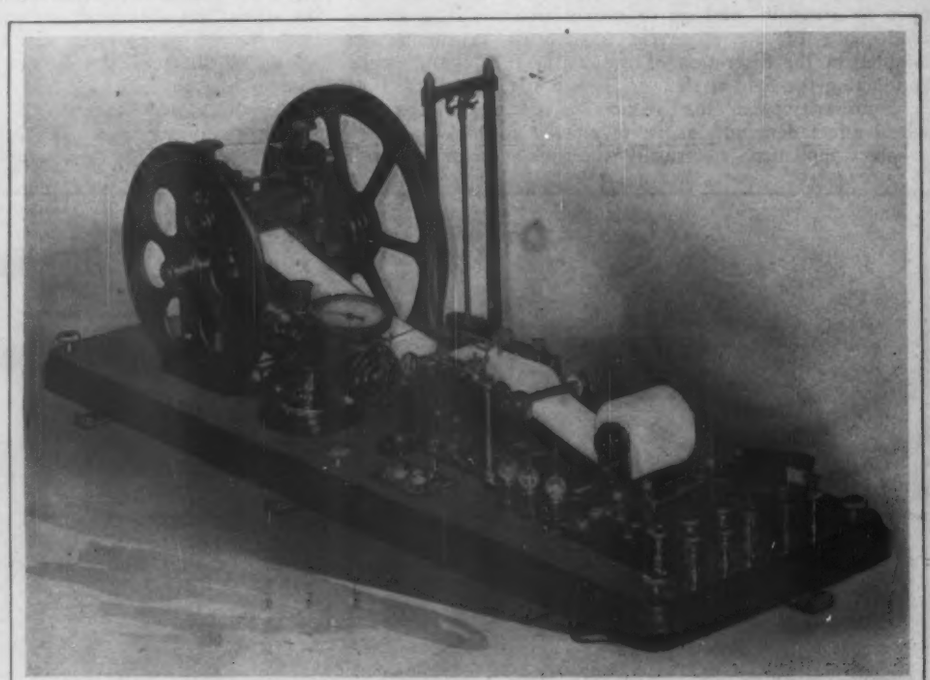
earlier passes and intervals being negotiated with great despatch and exactness.

From the arrangement of the miscellaneous data, given in the accompanying table and graphics, plotted from the several chart records (the latter taken during the test) a true index of the cyclical variations such as instantaneous performances, time necessary to accelerate and decelerate the rotating masses, elapsed periods, energy distributions at any point in the cycle, is so depicted in a pictorial sense as to reflect with emphasis the marked characteristics of the service.

The graphical exhibit thus enables the designer to specify without assumption the most economical engine or motor to install to insure a certain tonnage per unit of time, also the correct weight of flywheel to apply with the proper speed reduction. The tests invariably show also whether or not hit-and-miss principles were followed when the mills under investigation, for example, were equipped with motors. An explanation of the graphical representation for a specific application will perhaps best illustrate the author's method.

The complete diagram pictures a mill cycle of 69½ seconds duration, including the time lapses or intervals between rollings of the slab, and continues by repetition. The different curves may be distinguished by the different conventional lines as indicated, covering total mill load; or speed curve; load developed in the cylinders; flywheel effect; mean effective pressure of the crank ends of the high and low pressure cylinders referred to the low pressure cylinder; the mean effective pressure of the head ends referred to the low pressure cylinder, and the total mean effective pressure of the whole unit referred to the low pressure cylinder.

The revolutions of the engine and second intervals are plotted as abscissæ, and the collective power requirements at each instant in the rolling cycle are plotted as ordinates.



Another View of the Instrument for Measuring the Angular Velocity Variations, Flywheel Effects, Etc.

Taking up the curves separately, we will discuss their properties, pertinent to the designing engineer. Since the integrated value of the cylinder load curve—read on the horsepower scale for the average power the cylinders would normally have to develop—figures 978 hp., including friction, the size and type of power generator can readily be determined from the character or nature of the work as indicated by the companion curves. Ranking equally in importance, if satisfactory service and specified tonnage are to be maintained, or the next step demanding attention is the size and proper weight of the flywheel. The values are closely dependent on the speed variations allowable; the lighter the flywheel the greater the variation.

Instead, however, of assuming definitely fixed speed limits in the beginning, reference to the speed curve in conjunction with the mill load curve furnishes ample data upon which to base the calculations. Knowing from the speed curve plotted in its true relation with the other events occurring in the cycle, the speed reductions permissible during the heaviest peak loads, and the space available at the engine, as well as the critical peripheral speed allowable for the material, we decide to use in its construction, a study of the two curves will aid in the computing of the necessary weight and the energy required of the flywheel.

The mill load curve registers the frequency and duration of the peaks, also their magnitude above the average power developed in the cylinders, during which period the wheel is called upon to pay out energy to the system. Similarly it registers the number and extent of the intervals when the mill load is below the normal and the energy expended during these intermissions is available for storing in the flywheel and the acceleration of the rotating masses. The quantitative measurements of all these quantities are absolutely essential to the intelligent design of regulators if the speed variations and cylinder efforts are not to exceed specified limits.

Referring now to the flywheel curve, a casual inspection of its peculiarities cannot fail to impress one of the enormous capacity of the flywheel as an energy reservoir and the important part it plays in rolling mill practice. It responds instantly and vigorously when its services are demanded and assists the governor over insurmountable obstacles such as the peaks encountered, rising abruptly to four times the normal load.

The combined mean effective pressure curve values rise and fall in practical synchronism with the engine power curves, on account of the increments in mean effective pressure due the lengthened cut-offs which offset the drops in speeds. Therefore, such points afford a check on the efficiency of the flywheel as an equalizer. In the present instance, for example, the curves indicate that more flywheel effect would prove beneficial, eliminating to a greater extent the sinuous wave form of these curves, with a consequent drop of the maximum mean pressures carried in the steam cylinders.

Having now discussed a rational method whereby the size of motive power and dimensions of flywheel for any stated speed reduction may be determined from the charts, an examination of the table, arranged to invite inspection, will reveal a comprehensive outline of the service in its entirety.

The formulas and mathematical calculations used in connection with the numbers presented thereon are doubtless all familiar to the engineering fraternity and need not be gone over again. Attention, however, is directed to the small discrepancies in the footings of the different columns; selecting, for example, columns 33 and 34, covering respectively energy given out and energy restored. These summations should necessarily balance, since the speed reductions must be zero for the mill cycle, otherwise the engine would eventually become stalled from the nature of the cumulative losses. The discrepancy herewith noted of 0.04 per cent. can be attributed to the slide rule computations rather than to any inaccuracy of the field charts.

In order to render more pronounced the actual work performed by the engine during the cycle, the graphical

NO. OF PASS	Section 211 Sq.In. Wt. 1660 Lbs. 52.75	DIMENSIONS OF SLAB: THICKNESS	WIDTH	LENGTH	ENGINE REVOLUTIONS: PASS	INTERVAL	PASS AND INTERVAL	AREA OF SECTION	DRAFT	REDUCTION OF AREA OF SECTION		LENGTH OF PASS	ELONGATION: LENGTH	PER CENT	ROLLS: DIAMETER	REVOLUTIONS: PASS	INTERVAL	PASS AND INTERVAL	TIME: PASS	INTERVAL	PASS AND INTERVAL	NO. OF STOKES PASS AND INTERVAL	M.E.P. TO L.P. CYL.: PASS: HEAD END	CRANK END	INTERVAL: HEAD END	CRANK END	ENERGY EXPANDED DURING PASS AND INTERVAL: DEVELOPED BY CYLINDERS: TOTAL INDICATED WORK	FRICTION LOSS OF 62100 FT. LBS. STROKE	NET INDICATED WORK OF ENGINE	FLY WHEEL WORK: REVOLUTION: ITINIAL	FINAL	ENERGY: GIVEN OUT	RESTORED	TOTAL NET WORK BY ENGINE AND WHEEL	VARIATION IN SPEED FROM NORMAL
	SECTION OF SLAB	IN.	IN.	IN.				SQ. IN.	IN.	SQ. IN.	%	FEET	FT.	%	IN.				SEC.	SEC.	SEC.		STROKE BASIS LBS.	STROKE BASIS LBS.	STROKE BASIS LBS.	STROKE BASIS LBS.	FT. LBS.	FT. LBS.	FT. LBS.	R. P. M.	R. P. M.	FT. LBS.	FT. LBS.	FT. LBS.	PER CENT
1		3.5	52.75	32.16	0.388		4.61	184.5	0.5	26.5	12.6	2.63	0.266	11	30.125	0.34		4.03	0.357		4.06	9.22		46.2			184.000	48.200	136.300	68.45	66.798	325.000		461.300	−3.62
						4.22											3.69			3.70					48.40	64.0	1.157.000	524.000	633.000	66.798	69.9		634.000		+0.09
2		3	52.75	37.68	0.446		5.91	158.25	0.5	26.25	14.2	3.14	0.46	17.2	30.0625	0.39		5.23	0.399		5.21	11.93	11.28				51.800	55.400	−3.600	69.9	67.02	594.000		590.400	−3.04
						5.54											4.84			4.81					45.8	82.7	1.325.000	688.000	637.500	67.02	70.239		650.000		+0.14
3		2.5	52.75	45.12	0.548		4.53	131.9	0.5	26.35	16.6	3.76	0.62	19.7	30.125	0.48		3.98	0.48		4.05	9.10	7.77				44.000	68.100	−24.100	70.239	63.81	1.280.000		1.256.900	−7.95
						4.00											3.50			3.57					74.1	98.7	1.779.000	496.000	1.283.000	63.81	70.398		1.388.000		+0.16
4		2	52.75	56.28	0.685		4.39	105.5	0.5	26.4	20.0	4.69	0.93	24.8	30.0625	0.60		3.84	0.598		3.94	8.78	5.41	5.41			77.400	85.000	−7.600	70.398	63.996	1.350.000		1.342.400	−7.65
						3.711											3.34			3.34					60.8	99.7	1.655.000	461.000	1.194.000	63.996	70.266		1.315.000		+0.14
		2	56.28	52.75				112.56																											
5		1.5	56.28	70.44	0.857		3.96	84.42	0.5	28.14	25.0	5.87	1.48	33.8	30.125	0.75		3.46	0.792		3.62	7.92	11.72	29.2			431.300	106.500	324.800	70.266	60.396	1.980.000		2.304.800	−12.80
						3.10											27.1			2.83					93.4	93.45	1.911.500	385.000	1.526.500	60.396	69.3		1.740.000		0.00
6		1.125	56.28	93.84	1.132		4.58	63.31	0.375	21.11	25.0	7.82	1.95	33.2	30.0625	0.99		4.01	1.05		4.18	9.16	12.64	46.1			605.000	141.000	468.500	69.3	62.112	1.480.000		1.888.000	−10.40
						3.45											3.02			3.13					100.5	96.1	2.000.000	428.000	1.572.000	62.112	69.732		1.580.000		+0.06
7		0.875	56.28	120.60	1.463		4.33	49.24	0.25	14.07	22.2	10.05	2.23	28.6	30.125	1.28		3.79	1.38		3.98	8.66	14.31	52.0			684.300	182.000	498.000	69.732	61.608	1.610.000		2.108.000	−11.10
						2.87											2.51			2.60					82.6	89.9	1.776.200	356.000	1.420.200	61.608	69.03		1.460.000		0.00
8		0.625	56.28	169.20	2.05		5.07	35.17	0.25	14.07	28.6	14.10	4.05	40.2	30.0625	1.79		4.43	1.97		4.90	10.14	41.2	69.8			1.143.300	254.300	889.000	69.03	56.778	2.320.000		3.209.000	−13.20
						3.02											2.64			2.93					114.8	120.0	2.415.000	375.000	2.040.000	56.778	56.036		1.705.000		−4.75
9		0.500	56.28	211.31	2.66		5.54	28.14	0.125	7.03	19.8	17.61	3.51	24.9	30.125	2.24		4.84	2.44		5.32	11.08	87.3	77.2			1.695.000	318.000	1.377.000	56.036	60.2	1.105.000		2.482.000	−13.10
						2.98											2.60			2.88					79.3	105.4	1.904.000	370.000	1.534.000	60.2	67.099		1.330.000		−3.18
10		0.375	56.28	282.06	3.42		6.25	21.10	0.125	7.04	25.1	23.5	5.89	33.4	30.0625	2.99		5.46	3.32		6.30	12.50	79.3	121.7			2.072.000	425.000	1.647.000	67.099	54.491	2.310.000		3.957.000	−21.40
						2.83											2.47			2.88					120.9	114.8	2.428.000	352.000	2.076.000	54.491	65.4		2.070.000		−5.65
11		0.3125	56.28	338.40	4.11		7.65	17.59	0.0625	3.51	16.6	28.2	4.7	29.0	30.125	3.58		6.67	4.10		7.41	15.30	146.7	161.9			3.310.000	499.000	2.811.000	65.4	57.99	1.380.000		4.191.000	−16.30
						3.54											3.09			3.31					120.7	117.3	2.442.500	439.000	2.003.500	57.99	70.2		2.160.000		+0.13
12		0.25	56.28	422.50	5.14		5.14	14.07	0.0625	3.52	20.0	35.21	7.0	24.8	30.0625	4.49		4.49	4.58		4.58	10.28	73.4	94.4			1.726.000	638.000	1.088.000	70.2	65.814	895.000		1.983.000	−5.05
																														65.814	68.45		827.500		
TOTAL					22.79	30.28	62.07									19.92	34.31	54.23	21.46	35.97	57.44	124.12	491.03	703.91	941.3	1081.05	32.217.800	7.394.500	25.124.000			16.500.000	16.499.500	25.672.800	

GRAPHICAL EXHIBIT CARD NO. 7

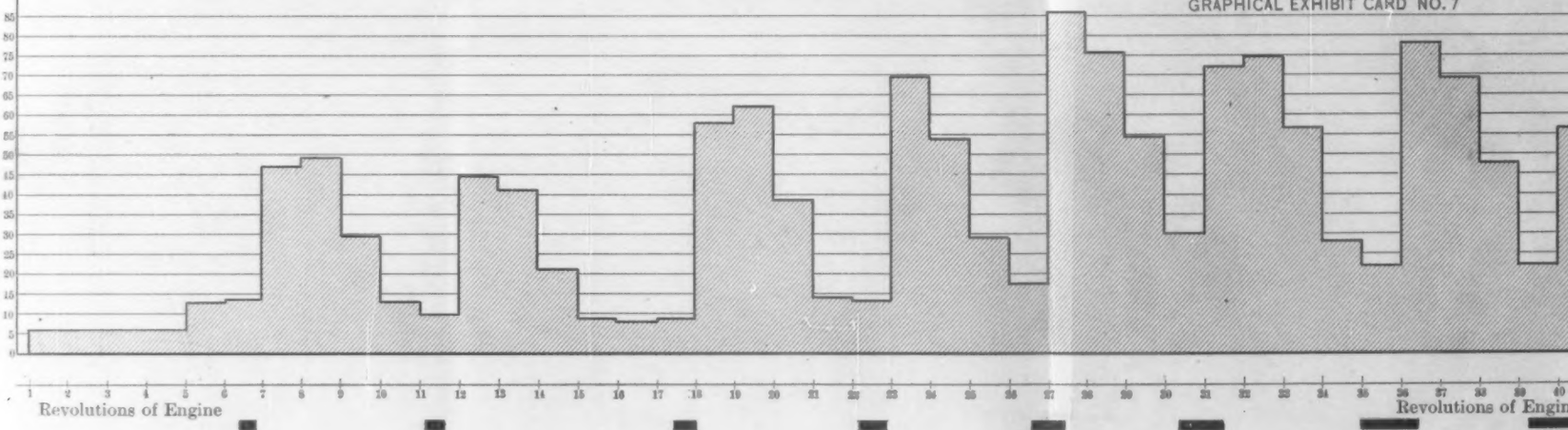
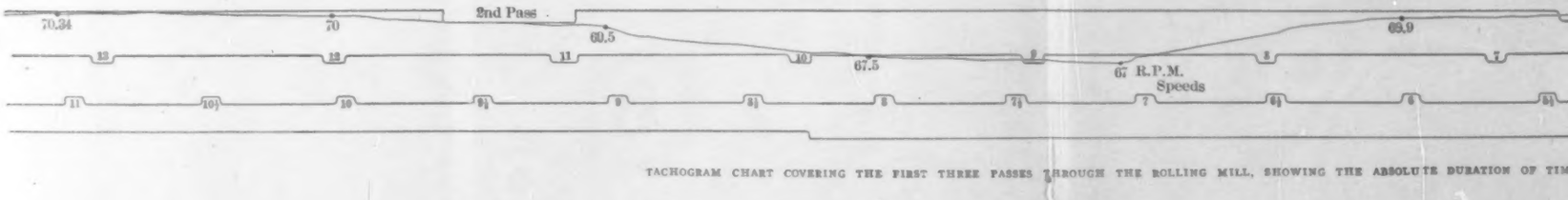
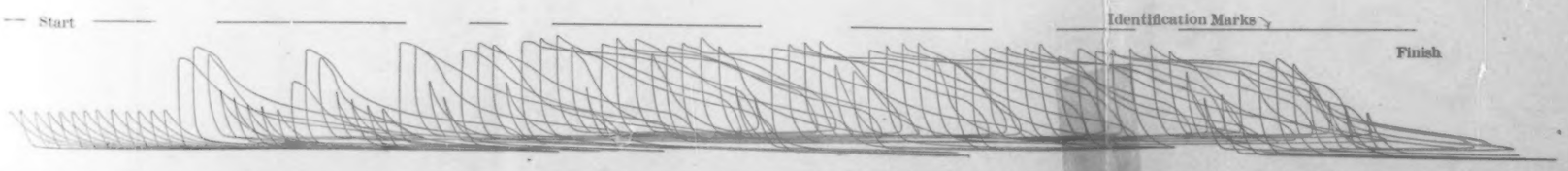


TABLE OF DATA AND CALCULATIONS AND CARD OF VARIATIONS OF STEAM E



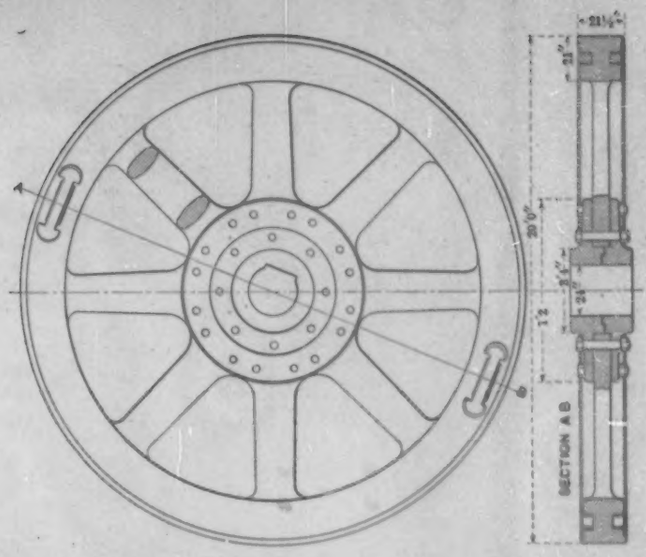
TACHOGRAM CHART COVERING THE FIRST THREE PASSES THROUGH THE ROLLING MILL, SHOWING THE ABSOLUTE DURATION OF TIM



CONTINUOUS INDICATOR CARD OF HEAD END OF HIGH-PRESSURE CYLINDER, SHOWING USE OF IDENTIFICATION MARKS; SCALE OF SPRING FOR REDUCED SIZE OF CORD, 160 LB.

CHARTS, CARDS, TABLE AND DATA USED IN THE STUDY OF

36	37	38	39	40	41	42	43	44	45	46	47
ATION IN EED ROM RMAL	SQ. IN. REDUCTION AND FEET LENGTH	NET WORK PER SQ. IN. REDUCTION PER FEET LENGTH	TEMPERATURES: CALCULATED DROP DURING PASS AND INTERVAL FAHRENHEIT	TEMPERATURES: AVERAGE WHILE ROLLING FAHRENHEIT	NET POWER DEVELOPED IN CYLINDERS	NET LOAD ON MILL DURING PASS	TANGENT'L FORCE AT ROLL SURFACE	STEAM CONSUMPTION: INDICATED: PASS AND INTERVAL	STEAM CONSUMPTION: INDICATED: I. H. P. PER HOUR	STEAM CONSUMPTION: CORRECTED: I. H. P. PER HOUR	STEAM CONSUMPTION: CORRECTED: PASS AND INTERVAL
CENT		FT. LBS.	DEGREES	DEGREES	I. H. P.	H. P.	POUNDS 1 FT. RAD.	LBS.	LBS.	LBS.	LBS.
3.62	71.0	6,510		2123	695	2,950	171,800	11.84	17.5	21.8	14.75
3.09			36		311						
3.04	88.5	7,210		2002	— 16	2,700	192,660	11.3	14.5	20.6	14.15
0.14			46		341						
7.95	99.5	12,300		2046	— 92	4,750	332,000	16.0	17.3	21.7	20.0
0.16			25		655						
7.95	123.8	10,200		2011	— 82	4,060	284,000	14.25	17.3	21.9	17.8
3.14			34		650						
2.80	105.0	13,100		1977	745	5,070	375,900	20.29	17.2	21.5	23.4
3.09			32		980						
0.40	105.0	11,500		1945	812	3,270	242,000	22.03	13.0	20.5	20.6
0.96			30		915						
4.10	141.3	14,200		1909	657	2,780	199,000	18.20	14.4	18.30	22.75
3.00			35		995						
8.20	198.0	16,200		1874	882	2,940	228,000	20.76	17.0	21.25	23.25
.75			43		1,245						
8.10	124.0	20,500		1831	1,025	1,550	180,500	27.00	15.5	19.40	34.50
.18			47		970						
1.40	165.5	23,800		1784	903	2,160	168,000	39.75	17.5	21.85	42.9
.65			51		1,310						
3.30	99.0	33,300		1730	1,245	1,255	146,000	42.90	14.9	18.65	52.8
3.13			65		1,190						
3.05	124.0	16,200		1665	355	788	56,100	17.30	17.1	21.35	21.6
			41	1624							
		196,530			16,580	34,623	2,534,100				341.5



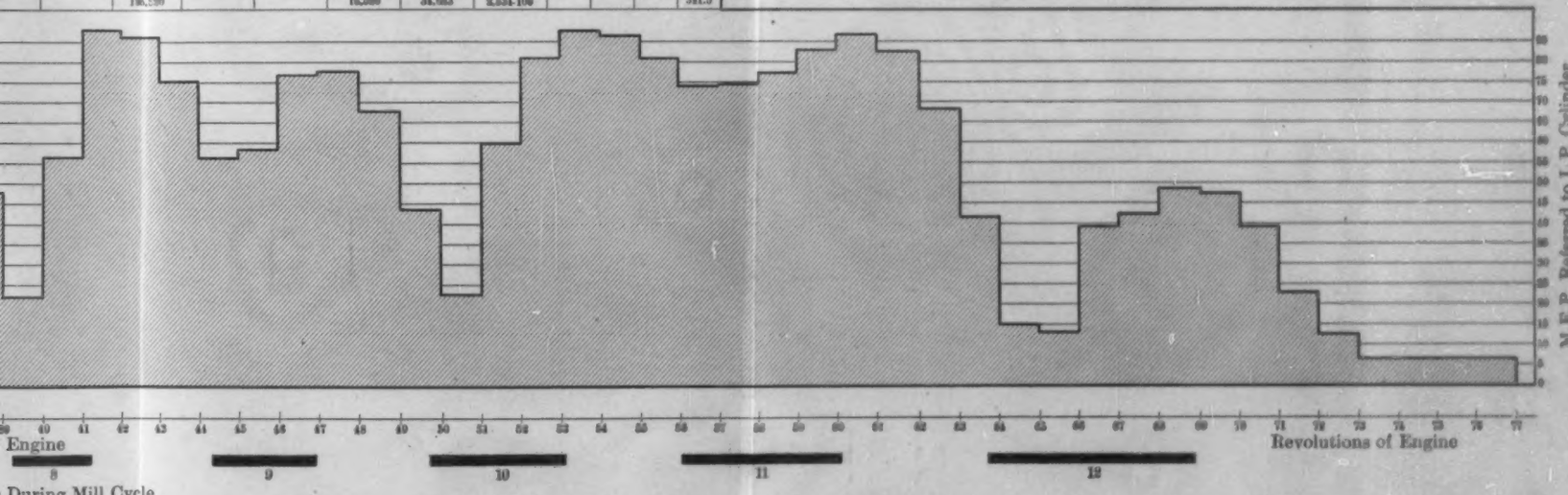
DATA PERTAINING TO THE 72-IN. MILL TEST

Engine: Piston valve tandem-compound 32x52x60-in. engine operated condensing; rating, 1800 hp. at 35 per cent. cut-off and 85 r. p. m.; maximum variation while rolling, 15.5 per cent.; minimum speed while rolling, 54.5 r. p. m.; average power developed, 975 ihp.

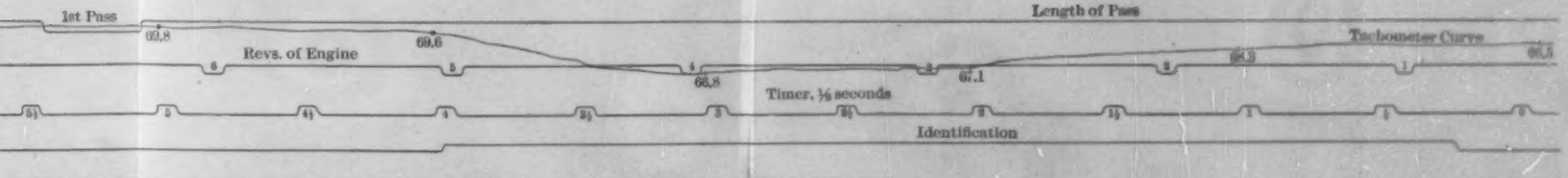
Roll Mill: Diameter of upper roll, 30 1-16 in.; middle roll 18 7-16 in.; bottom roll, 30 1-2 in.; ratio of engine to mill pinions, 14 to 16.

Flywheel: Diameter of flywheel rim, 20 ft.; weight of hubs and arms, 37,000 lb.; weight of rims and links, 73,000 lb.; total weight of wheel, 110,000 lb.; radius of gyration, 8.99 ft.

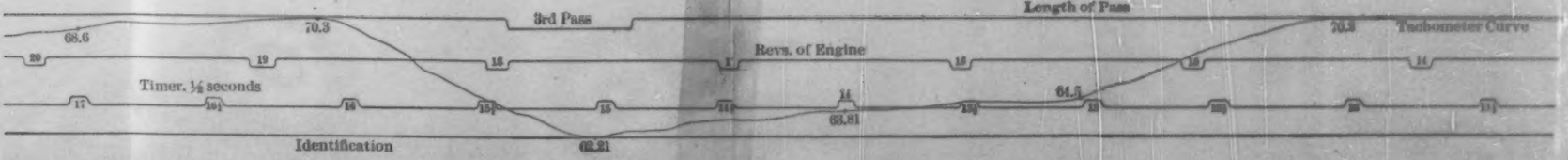
Slab: Loss in reheating furnace, 3 per cent.; net weight of slab as rolled, 1610 lb.; size of plate as rolled, 56.28x422.5x¼ in.; weight of slab rolled, 1392 lb.; size of sheared plate 50 3-4x387x1-4 in.



AM ENGINE CYLINDER PRESSURES IN ROLLING A SLAB INTO A PLATE



OF TIME, THE NUMBER OF ENGINE REVOLUTIONS, THE INSTANTANEOUS VARIATIONS IN SPEED AND THE IDENTIFICATION LINE



CONTINUATION OF THE TACHOGRAM COVERING THE FIRST THREE PASSES THROUGH THE ROLLING MILL

OF THE POWER REQUIREMENTS OF THE ROLLING MILL

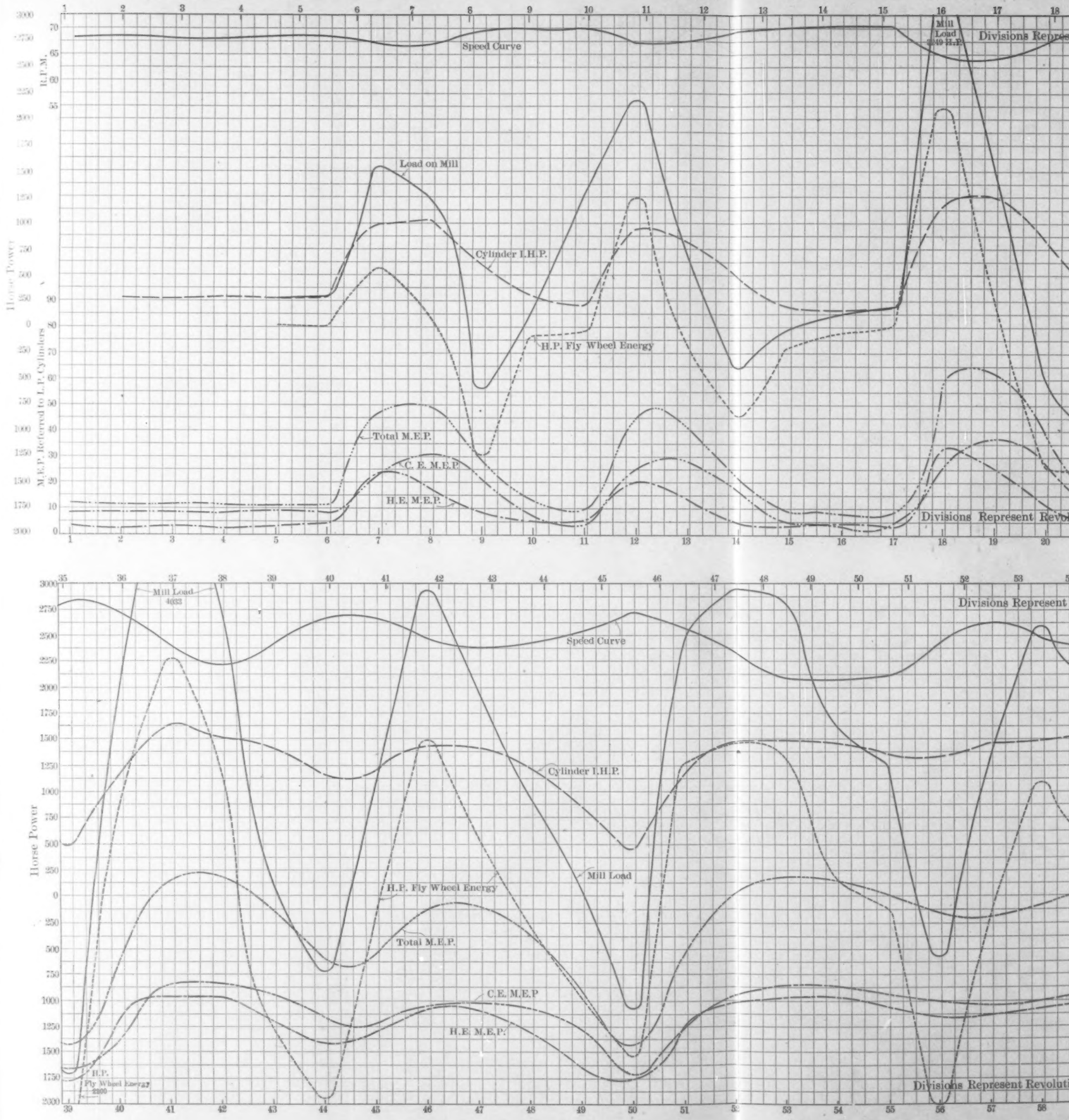
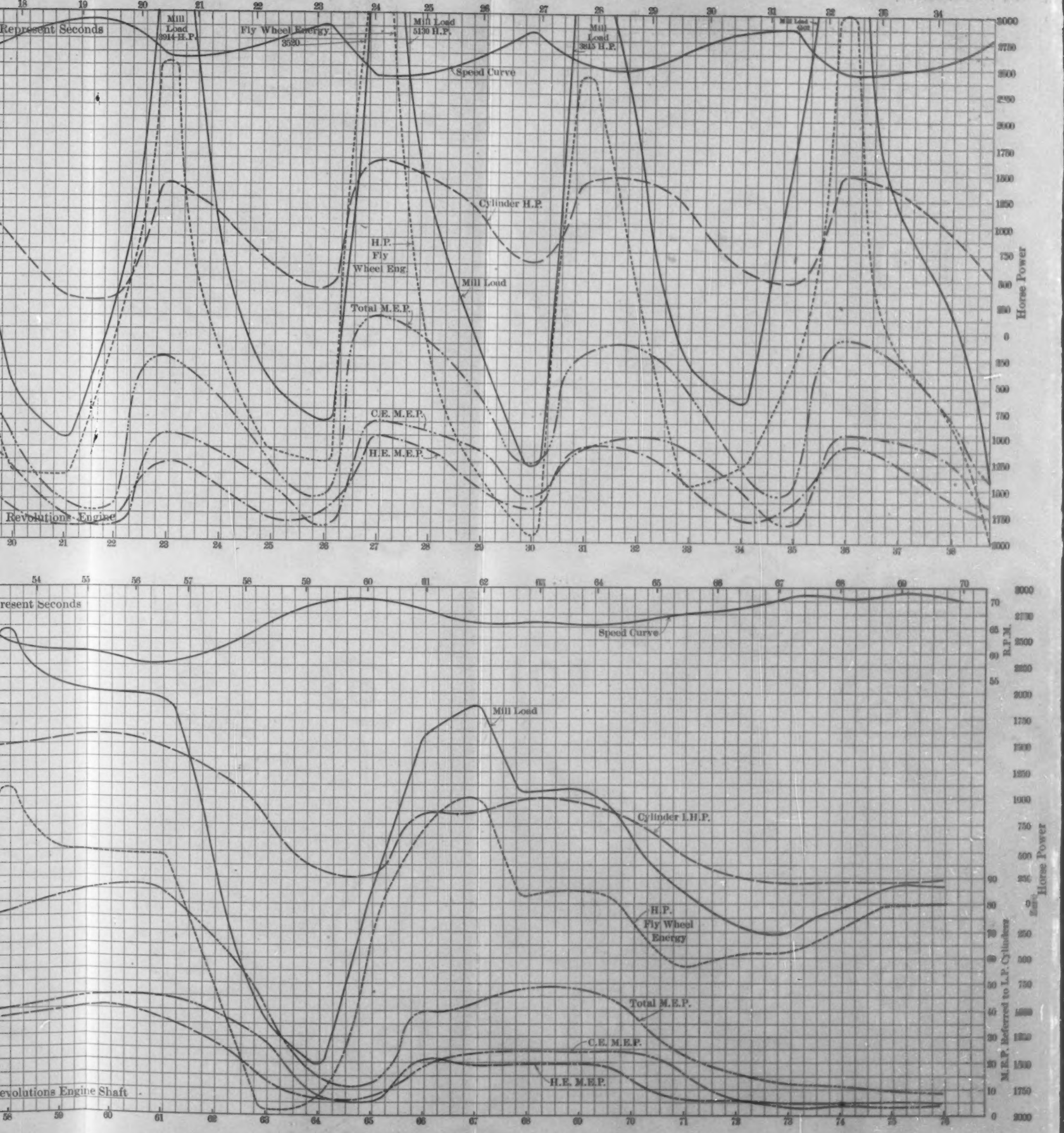


DIAGRAM EXHIBITING A MILL CYCLE OF 69½ SECONDS DURATION, SHOWING RELATIONS OF T



OF TOTAL MILL LOAD, SPEED, POWER SUPPLIED BY MILL ENGINE AND FLYWHEEL EFFECT

exhibit of Card 7 is traced on the log sheet. To facilitate the plotting of the chart, the mean effective pressures for each set (four continuous cards per set) of diagrams were tabulated in the proper order of sequence of strokes; the combined mean effective pressures per stroke calculated by dividing the high pressure mean effective pressures by the cylinder ratio and adding to the simultaneous low pressure mean effective pressures.

Reverting to the data sheet, these combined mean effective pressures were multiplied by the low pressure cylinder area in square inches and stroke in feet, to convert them into foot-pounds of work per stroke. These figures were then divided into groups representing passes, according to the number of strokes, determined by the length of pass marked on the tachogram, and into intermediate groups representing intervals between passes. Totals for these groups are tabulated under "Total Indicated Work, Ft.-Lb."

From the relative position and length of the mill passes, an idea can be framed of the efficiency of the governing mechanism as a whole. The later passes, due to their continued durations and lessened temperatures, early exhaust the storage energy of the flywheel and demand the attention of the governor over extended periods to maintain the speed within fixed limits. Thus, with suitable apparatus at his command, capable of securing the data necessary for establishing the aforesaid curves, the designing or field engineer would be able to diagnose the most troublesome cases, and apply the proper remedy.

Since the power required for rolling depends upon the plasticity of the material, therefore to a large extent on the temperature, temperature measurements form an important factor. They are quite germane to the subject under discussion, provided constants are to be developed on the basis of energy expenditure per square inch reduction of sectional area, per foot of length of piece, per degree drop in temperature. These observations must necessarily be of short duration, in order not to unduly interfere with the operation of the mill. Thus color determinations, in lieu of more refined readings, due to the lack of suitable pyrometers, have heretofore been resorted to.

To overcome this deficiency, a platinum-platinum-rhodium thermo couple, naked at the hot junction, was utilized in connection with a suspension type galvanometer. The couple was hooded with a specially designed hinged cover, to prevent excessive radiation. With this arrangement, one and one-half to two seconds sufficed for the exposure of the hot junction, care being taken to remove the surface scale at the point under observation, before applying the couple. To controvert suggestions relative to the use of radiating (fixed focus type) and optical pyrometers, I might add that attempts to employ said types have proved unsatisfactory in practice. The former is relatively sluggish in action and requires a correction factor, itself very uncertain. When the telescope is sighted on hot bodies out in the open, the latter type always demands more or less manipulation. Moreover, all steels while undergoing rolling are inclosed in an oxide envelope; thus surface temperatures somewhat lower than the actual temperature of the steel underneath are recorded, unless readings are taken directly the material leaves the rolls.

In conclusion, I might add that the inducements leading to the advancement of the various phases relating to rolled steel sections, together with the accompanying graphics and a detailed description of the functional capability of the tachographic recorder, arise from a two-fold object:

1. Standardized forms for calculating and reporting the conclusions deduced from the field tests.

2. A desire to encourage the substitution of adequate recording instruments, indispensable for the service intended, in lieu of the indicating type now marketed.

The advent of the former in the steel industry will not only place the considerations given these subjects on a scientific basis, but will offer splendid facilities for obtaining accurate information on which improvements may be based. A description of the apparatus is given below.

The following section of the article covers the features of a tachographic apparatus, designed primarily for determining the angular velocity variations, inertia and flywheel effects involved in the rolling of steel sections; the availability of the same instrument to investigate the critical speeds of generators operating in parallel, the sensitiveness of governing mechanisms attached to prime movers, and the minute irregularities and characteristics of motors under test.

Having dealt with the commercial aspect of the problem pertaining to the power required to drive rolling mills, it may be well briefly to consider the constructional features desirable in a combination tachographic outfit for studying the other side of the problem. With the facts gleaned from experience, and with a mind to the conditions the appliance is compelled to meet in mill practice, the design nevertheless should afford accessibility at every point, inviting frequent and careful attention toward maintaining accurate adjustment of its component parts.

To accomplish the results sought, the instrument as developed consists of a two high set of steel friction rollers, rubber-faced, to guarantee the integrity of the paper feed. The lower roller spindle is extended at each end to accommodate the belt cord pulley and the gear drive. All are mounted in rigid roll housings with thumb screw adjustments to regulate the pressure and prevent slippage of the marking strip. A removable spindle fitted with a spring device facilitates the mounting of the paper rolls and furnishes sufficient tension to cause a uniform feed of the chart.

A platen superimposed above the four electromagnets is located midway between the feed rollers and paper storage spindle, equipped with guide rollers at the proper positions to maintain a smooth marking surface over the platen. The electromagnets specially designed for rugged service, with exterior adjustment springs, are fitted with disconnected stylus arms, equipped with metallic points, the latter also independently adjustable and renewable.

As the stylus points are in continuous contact with the record chart, means are provided underneath the slot covers so that they will press with sufficient force on the paper to trace a clear line without undue friction of the sliding stylus arms in the guide slots. The intermittent excitations due the cyclic make and breaks cause the register lines to offset distinctly from the idle to the operating positions approximately ⅛ in., and of variable length, dependent on the rate of feed.

The stylus recorders, when the tachograph is in action, function as follows: No. 1 registers the strokes of the engine; No. 2 strikes the half seconds; No. 3 marks the length of pass; No. 4 traces the identification line; while the recording tachometer marks the instantaneous fluctuations in speed. The tachometer is geared in the ratio of 1 to 10 and the needle arm is pivoted to secure maximum throw within the paper limits and the speed variations ordinarily encountered in mill practice. Thus neither the curve traced nor the indicator dial reading will represent the true engine speed. However, the curve may be at once calibrated from the simultaneous stroke and seconds' records.

A sample of the tachographic chart is given among the illustrations. The excitation of the stroke magnet is furnished by siutable make and breaks erected at convenient reciprocating points of the machine under test. The timer is controlled from a half-seconds pendulum, passing over a mercury bath with platinum contact point. This pendulum, suspended from case-hardened knife edges and sockets in standards attached to the base board, possesses sufficient energy when once set in motion to maintain its oscillations indefinitely, being practically vibration-proof.

The length of pass, at all times a troublesome quantity to determine with any degree of accuracy (especially in the initial passes, owing to the brief time interval elapsing in some instances, in fact ranging as low as 3/10 second), is in the case at hand automatically plotted from electrode contacts, arranged at the pinion end of the carrier cradle. This necessitates, however, previous adjustment of the carrier springs.

Since experience demonstrates the necessity of abso-

lute accuracy in the identification of the tachogram with its corresponding cylinder diagrams, this fact being particularly emphasized with rapidly fluctuating loads and sensitive governors, means are provided in the present apparatus positively to identify one with the other by mounting two electromagnets, one on the continuous steam cylinder indicator instrument, and the other actuating a stylus pencil on the speed chart of the tachogram, both operating in parallel from the same push button. The identification of simultaneous values on the two charts being of paramount importance, in order to compare and interpolate properly the speed chart at any particular instant with its corresponding indicator diagram or any combine than those from tandem engines, owing to the position of the cranks), an examination of the respective continuous diagrams taken from the different cylinders will readily show the correct combination for each stroke and obviate the necessity of utilizing more than the one electromagnet mounted at the indicator instruments. An extra push button is also provided at the tachograph to actuate the magnets attached to the pencil levers on the indicators, thus insuring the striking of simultaneous diagrams from all the cylinders. Otherwise, the push button may be employed to signal the attendants at the instruments, if they are not so equipped.

The charts or tachograms adapted for the instrument

Table of Horse Power Developed and Flywheel Effect

Cylinder Data				Flywheel Data						
						Energy				
No. of Card.	M. E. P. referred to L.P.cyl.,lb.	Speed of Engine, r.p.m.	Indicated hp.	Initial speed r.p.m.	Final speed r.p.m.	Given out per rev. ft. lb.	Restored per rev. ft. lb.	Given Out hp.	Restored hp.	Total load or mill hp. per rev.
1.	12.6	68.45	269.1	68.45	68.45	.....	.....	.....	.....	269.1
2.	13.5	68.45	288.2	68.45	68.45	.....	.....	.....	.....	288.2
3.	47.	67.10	985.0	68.45	67.1	291,000	.....	562	.....	1547.
4.	49.4	66.80	1028.0	67.1	66.8	60,000	.....	115	.....	1243
5.	29.6	69.60	644.0	66.8	69.6	.....	616,000	.....	1234	—590
6.	12.9	69.80	280.9	69.6	69.8	.....	642,800	.....	86	194.9
7.	9.7	69.90	210.0	69.8	69.9	.....	17,100	.....	34.5	175.5
8.	45.3	67.01	948.0	69.9	67.01	634,000	.....	1225	.....	2173.
9.	41.2	67.5	867.5	67.01	67.5	.....	111,000	.....	216	651.5
10.	21.3	69.50	462.0	67.5	69.5	.....	436,000	.....	873	—411
11.	8.4	70.0	183.1	69.5	70.0	.....	111,000	.....	216	—22.9
12.	7.8	70.34	170.3	70.0	70.24	.....	25,625	.....	51.8	118.5
13.	8.1	70.2	176.9	70.24	70.2	8,550	.....	17.3	.....	194.2
14.	58.2	64.5	1169.0	70.2	64.5	1,119,000	.....	2080.	.....	3249
15.	62.	63.81	1233.0	64.5	63.81	145,000	.....	268	.....	1501
16.	38.6	62.2	810.	63.81	67.2	.....	702,000	.....	1355.	—545
17.	14.1	70.30	309.2	67.2	70.3	.....	668,000	.....	1350.	—1040.
18.	13.6	70.39	298.5	70.3	70.39	.....	25,625	.....	51.8	246.7
19.	69.6	64.	1389	70.39	64	1,369,000	.....	2525.	.....	3914
20.	53.6	64.5	1078.	64	64.5	.....	119,700	.....	222	856
21.	29	67.3	609.	64.5	67.3	.....	582,000	.....	1124	—515
22.	17.5	70.26	385.5	67.3	70.26	.....	625,000	.....	1256	—873.5
23.	85.5	60.4	1610	70.26	60.4	2,019,000	.....	3520	.....	5130
24.	75.6	61.1	1440	60.4	61.1	.....	145,400	.....	256	1184
25.	54.3	64.8	1098	61.1	64.8	.....	736,000	.....	1370	—272
26.	30	69.3	649	64.8	69.3	.....	968,000	.....	1930	—1281
27.	71.8	63.	1410	69.3	63.	1,326,000	.....	2405	.....	3815
28.	74.2	62.11	1439	63.	62.11	171,000	.....	360	.....	1799
29.	56.9	66.	1170	62.11	66	.....	779,000	.....	1480	—310
30.	28.2	69.	607.5	66.	69	.....	650,500	.....	1290	—682.5
31.	21.8	69.73	474.	69	69.73	.....	162,600	.....	326	148
32.	77.6	61.6	1492	69.73	61.6	1,695,000	.....	3010	.....	4502
33.	68.7	62.2	1333	61.6	62.2	.....	111,000	.....	199	1134
34.	47.8	64.1	957	62.2	64.1	.....	385,000	.....	710	247
35.	22.2	69.3	480	64.1	69.3	.....	1,104,000	.....	2200	—1720.
36.	56.6	67.	1182	69.3	67.	505,000	.....	975	.....	2157
37.	87.6	60.5	1653	67	60.5	1,310,000	.....	2280	.....	4033
38.	85.5	56.78	1513	60.5	56.78	694,000	.....	1135	.....	2648
39.	74.3	60.8	1410	56.78	60.8	.....	754,000	.....	1320	90
40.	56.3	65.9	1156	60.8	65.9	.....	1,018,000	.....	1930	—774
41.	58.5	66.04	1204	65.9	66.04	.....	42,800	.....	81.5	1122.5
42.	74.9	62.	1446	66.04	62	840,000	.....	1500	.....	2946.
43.	75.5	60.2	1412	62.	60.2	342,500	.....	594	.....	2006.
44.	65.2	61.1	1240	60.2	61.1	.....	171,000	.....	305.	935
45.	43.8	63.2	864	61.1	63.2	.....	428,000	.....	778	86
46.	22.1	67.1	462.5	63.2	67.1	.....	796,500	.....	1535	—1072.5
47.	60.	63.8	1191.	67.1	63.8	694,000	.....	1275	.....	2466
48.	80.9	59.4	1498	63.8	59.4	856,000	.....	1463	.....	2961
49.	87.5	54.5	1483	59.4	54.5	873,000	.....	1370	.....	2853
50.	86.4	54.49	1466	54.5	54.49	8,560	.....	134	.....	1600
51.	80.5	54.8	1375	54.49	54.8	.....	59,950	.....	94.5	1280.5
52.	74.2	61.	1410	54.8	61.	.....	1,128,000	.....	1980	—570
53.	74.4	65.4	1518	61.	65.4	.....	873,000	.....	164	1354
54.	77.2	62.3	1500	65.4	62.3	616,000	.....	1105	.....	2605
55.	82.8	60.7	1566	62.3	60.7	308,000	.....	539	.....	2105
56.	86.3	59.5	1603	60.7	59.5	231,000	.....	396	.....	1999
57.	82.3	57.99	1487	59.5	57.99	291,000	.....	486	.....	1973
58.	68.	60.2	1274	57.99	60.2	.....	419,500	.....	725	549
59.	41.4	65.4	844	60.2	65.4	.....	1,026,000	.....	1930	—1086
60.	15.	69.6	326	65.4	69.6	.....	916,500	.....	1835	—1509
61.	12.6	70.2	276	69.6	70.2	.....	102,600	.....	207	69
62.	39.9	68.5	854	70.2	68.5	351,000	.....	693	.....	1574
63.	42.4	66.	874	68.5	66.	531,000	.....	1010	.....	1884
64.	48.7	65.8	1000	66.	65.8	34,250	.....	65	.....	1065
65.	47.4	65.5	969	65.8	65.5	68,500	.....	129	.....	1098
66.	39.4	65.81	809	65.5	65.81	.....	77,000	.....	146	663
67.	22.5	67.3	472.5	65.81	67.3	.....	299,500	.....	580	—107.5
68.	12.1	68.45	254.	67.3	68.45	.....	239,500	.....	470	—216

portion of same, the method pursued to establish the identification can best be described by referring to what actually takes place when they are in action.

With the indicator and tachograph stylus pencils in contact with their respective marking strips and the feeds on, the push button operating the electromagnets is depressed at brief intervals for indefinite periods, marking similar simultaneous lengths of offsets and idle lines or gaps on both charts. Therefore, from the relative position occupied by any particular engine diagram to the offset lines and gaps traced on the continuous indicator card or strip, such indicator card can be at once transferred to its corresponding speed reading (and only one point is correct) occupying the same relationship to like auxiliary lines registered on the tachogram.

Bearing in mind the type of engine under test (cards from cross compounds proving somewhat more difficult to consist of 150-ft. rolls of treated paper, 2¼ in. wide, tightly wound on hollow wooden spools. This not only furnishes ample space capable of recording several tests, but facilitates rapid substitution of a fresh supply when the service roll is exhausted. Moreover, as the paper travel averages 20 ft. per minute for the speeds ordinarily encountered in the rolling process—though the travel may be altered at the discretion of the experimenter, with offsets about 3 in. apart—the percentage of error due to discrepancies in the actual space measurements of the tachogram is materially reduced on account of the comparatively large spaces intervening between said offsets.

All the wiring being concealed, pilot incandescent lights are installed in the individual circuits, which flash at intervals in synchronism with the make and breaks of their respective circuits. Furthermore, all the lights, magnets, etc., are numbered to correspond with their binding posts,

so that faults that may develop in the electrical circuits are rendered visible and can be speedily remedied. Three spirit levels, countersunk in the base board of the instrument, are provided with six adjusting screws and nuts, together with swivel plates attached beneath, to insure a secure and rapid setting-up of the apparatus at any machine it is desired to test.

The transmission for the paper drive is effected by belt cord connection from the crank shaft in the case of continuous mills; but direct driven by 1/16-hp. direct-current motor through a proper gear reduction when connected to reversing mills; devices being provided in either case to secure instantly any desired range of speed.

All the mechanism, magnets, stylus levers, tracing points, paper feeds, pendulum, and switches are equipped with outside adjustments and energized from the one source of supply, a 6-volt storage battery. The whole apparatus is highly polished, compact and portable; all the parts nickel plated, and the whole is inclosed in a glass case fitted with sliding ends, the latter to be removed when in service. As all the tracing points continuously register on the same paper strip, any irregularities that might creep in—due the slippage of the feed, elasticity of the belt or vibrations and jerks, when connected to machines which fluctuate rapidly in speed—are correspondingly effected in magnitude at all the points, thus rendering the apparatus immune to errors from such effects.

With such an instrument, equipped as described, not only is the personal equation entirely eliminated, but, what may on first thought seem an impossibility, an exhaustive rolling mill test, with its many contingent variables, whether driven by simple or compound units, can be conducted with the services of but one man, namely the operator at the tachograph, concentration of the observations thus being the goal sought.

International Steam Pump Company

Report for Eighteen Months Ended September 30

The International Steam Pump Company, 115 Broadway, New York, has issued its full report covering the 18 months ended September 30, 1911. The fiscal year of the company has heretofore ended March 31. A summary of the income account for the 18-month period shows the following:

Total net profits of the associated companies...		$2,676,449
Less:		
Charges on account of funded debt.....	$880,176	
Dividends on preferred stocks.....	1,289,700	2,169,876
Carried to surplus.....		$506,573

The surplus account of the associated companies is presented as follows:

Undivided profits March 31, 1910.....	$3,340,649
Surplus arising through retirement of Blake bonds, less reserves, amounts written off, etc.....	256,113
Surplus arising from acquisition of Fred. M. Prescott Steam Pump Co.....	117,014
Surplus for 18 months ended Sept. 30, 1911.....	506,573
Undivided profits Sept. 30, 1911.....	4,220,349
Blake & Knowles surplus Sept. 30, 1911.....	973,221
Total surplus of associated companies Sept. 30, 1911....	$5,193,570

The consolidated balance sheet of the associated companies as of September 30, 1911, compares with that of March 31, 1910, as follows:

Assets.	Sept. 30, '11.	March 31, '10.
Real estate, buildings, equipment, good will investments in other companies, etc.....	$35,985,426	$34,112,886
Discount on bonds.....	1,235,863	1,193,038
Inventories	6,288,200	6,911,922
Accounts and bills receivable.....	3,564,653	3,286,028
Miscellaneous debtors.....	144,447	521,482
Balances in suspense.....	71,101	158,215
Associated company balances.....	39,108	31,168
Cash	837,837	574,204
Total	$48,166,635	$46,788,943
Liabilities.		
Common stock.....	$17,773,300	$17,787,300
Preferred stock.....	13,810,556	13,813,563
Bonds	10,645,700	9,468,655
Notes payable.....	.....	62,938
Trade accounts.....	261,553	380,156
Accrued interest on bonds, etc.....	311,707	158,581
Due for dividends payable after September 30	170,250	170,388
Surplus	5,193,570	4,947,362
Total	$48,166,635	$46,788,943

President Guggenheim's Comments on Business

The following statement by President Benjamin Guggenheim accompanies the financial tables:

"The additions and improvements to which reference was made in our last report have now been completed and the plants of your company have reached a high state of efficiency for economy of production and volume of output. The policy adopted for the promotion of our foreign interests is showing excellent results, both in increasing our export business from the American plants as well as in the building up of the manufacturing business of our various plants abroad, which are at present overcrowded with orders.

"Whatever the underlying reasons may be, commercial conditions in the United States have been unsettled for a long time and trade is not on an active basis. Purchases are still being made to meet immediate requirements only, and this has brought about, as always, undue and severe competition for the business being done. To some manufacturers of machinery this intense competition has brought about disastrous results. Fortunately the improvements in our manufacturing equipment and methods, with consequent reduced cost of production, have enabled us to meet this competition with a comparatively slight reduction of earnings. Had it not been for these lower prices the output for the year just closed would have exceeded the sales of the fiscal year 1907-1908, which was the largest business year in the history of the company.

"Since the last report the plant and property of the Fred. M. Prescott Steam Pump Company have been acquired and the balance of outstanding bonds of the Blake & Knowles Steam Pump Works paid. Moreover, important improvements have been made at all of our plants, and the new department for the manufacture of small gas and gasoline engines, built as an addition to the plant of the Power & Mining Machinery Company, amounting to a complete new plant, will be ready for the marketing of its product shortly after January 1, 1912. These large capital expenditures have materially increased our fixed charges and we have not yet derived the corresponding benefit in increased sales and profits. We expect, however, that this business will develop rapidly into large volume and there is every indication that it will yield very satisfactory results. In spite of the continuance of business conditions which, to say the least, have not been favorable, our earnings have been well maintained."

Description of Plants and Products

An unusual feature for a company's report to its stockholders is the presentation of a description of its plants, business and products comprising 64 pages of text and illustrations. As many of our readers are not aware of the great scope of this company's business, we give the following list of its manufacturing plants:

In the United States.

Henry R. Worthington, Harrison, N. J.
Blake & Knowles Steam Pump Works, East Cambridge, Mass.
Clayton Air Compressor Works, East Cambridge, Mass.
Laidlaw-Dunn-Gordon Company, Cincinnati, Ohio.
Snow Steam Pump Works, Buffalo, N. Y.
Deane Steam Pump Company, Holyoke, Mass.
Holly Mfg. Company, Buffalo, N. Y.
Power & Mining Machinery Company, Cudahy, Wis.
Jeanesville Iron Works Company, Hazleton, Pa.
Denver Rock Drill & Machinery Company, Denver, Col.
Fred M. Prescott Steam Pump Company, Milwaukee, Wis.

In Europe.

James Simpson & Co., Ltd., Newark-on-Trent, England.
Worthington Pump Company, Ltd., London, England.
Societé Francaise des Pompes Worthington, Paris, France.
Worthington-Blake Pumpen Compagnie, Berlin, Germany.
Aktien Gesellschaft für Worthington Pump Maschinen, Vienna, Austria.

The plants of many of these companies are illustrated. Their products are likewise shown to a great extent. The report concludes with maps on which locations of the plants, branch offices and agencies are designated. So extensive are the company's operations that for this purpose a map of each grand division of the world is necessary.

American exports of tool steel to Germany may be curtailed by a discrimination in duties recently made by that country in favor of Swedish tool steel, said to be in retaliation for our giving Canada greater favors on wood pulp.

Notes on the Heat Treatment of Steel

What Is to Be Expected of the Practical Adaptation of Heat Treatment in Connection with Shop Management

BY HENRY SOUTHER.

Wonderful strides have been made in the art of heat treating steel in the last few years. Notwithstanding this great advance, it is a fact that a very large percentage of metal users are still prone to give this subject but scant consideration. Judging from personal contact with many classes of steel users, the writer is inclined to assign, as the reason for this reluctance to take advantage of a process manifestly so useful and valuable, a lack of knowledge as to what proper heat treatment of steel really is and really does; not to ignorance, but to misconception of the facts.

Mystery still surrounds steel in the minds of many users and in the minds of many who have used steel for a lifetime and whose fathers before them did the same. The steel maker used to be in the same class not so long ago, before chemist and metallurgist commenced to play their important part in the production and use of steel. The spread from producer to user of the knowledge that banishes mystery has been slow. The steel producer believed it to be to his advantage to retain his knowledge for his own use; and, in fact, it could not be spread very rapidly—it was too difficult to impart it through the salesmen missionaries of the industry at that time. Now, however, the real truth is spreading rapidly through the efforts of a small army of technical graduates who have been trained and finished by thorough and practical experience in the steel works of the United States.

The Automobile Industry and Heat Treatment

In one industry, in particular, the adoption of heat treating methods has been very extended and very rapid, and that is the automobile industry. This is undoubtedly due to the very exacting demands met in this field; where every part must possess the maximum degree of strength and toughness combined, coupled with a minimum of weight.

The automobile manufacturer has been assisted in the solution of his problem by the campaign of education instituted about five years ago by the mechanical branch of the Association of Licensed Automobile Manufacturers, which work is now being carried on even more forcefully by the Society of Automobile Engineers. The Iron and Steel Committee of this society has formulated and is formulating standard specifications to be used in the selection and purchase of steels; but incident thereto, and of equal importance to the users of steels, are the instructions, notes and explanatory matter that are prepared and placed before the members of the society. This latter feature serves as a very strong educational factor.

The views of producer and consumer have been exchanged in the meetings of this committee; differences have been and are being reconciled; "mysteries" have been obliterated, and the simple truths underlying the art of heat treatment are being brought out and placed before the steel users. The result of all this is a real understanding of the whole matter from all viewpoints, and correspondingly rapid progress in the intelligent handling of steel.

The Object of Heat Treating Steel

The object of heat treating a piece of steel is to put it into the proper physical condition for any given use. The word "piece" is used advisedly, rather than the word "kind" or "quality.". The size of the piece, its thickness, shape, the machining operations through which it must pass—all exert more or less influence upon the treatment. This brings out the important fact that no one set of general rules will provide a treatment that will apply to all cases. The man on the job must understand the qualities sought in a given piece, and must exercise a large measure of common sense in the applications of the principles. One who believes he can work under a set of hide-bound rules for all parts, regardless of their composition or ultimate use, is bound to experience failure.

Heat treatment covers a group of operations in varying sequence. All the operations have been known to steel users for generations; all sequences have not or, if they have, they have not been used in a commercial sense. Perhaps the best illustration of the form of heat treatment long used is that resorted to in the production of a cutting tool. The sequence of operations in this instance is the annealing of the steel at the steel mills, subsequently followed by heating, quenching and drawing, or tempering, at the hands of the tool maker in the shop of the user. This practice has always been followed with the sole purpose of obtaining a hard, strong, cutting edge; in other words, to improve a piece of steel for a given object.

For a long time no attempt was made to similarly treat steel intended for other parts than tools, that is, structural steels; and yet just as much improvement is possible with such material as with the tool steels.

Refinement by Hammering

One other form of treatment was used to improve steel, and that is the careful hammering of the material. It was and is understood in many circles that a piece of hammered steel is to be preferred to stock worked in any other way. There is a reason for this, and it is very simple. The size of the grains or crystals is much reduced by careful hammering, and the steel is thereby refined.

This very quality—refinement—is better attained by suitable heat treatment, by which method it is under absolute control. In short, the user of steel may refine, and should refine, all steel going into parts where strength, toughness or hardness is required. The degree of each of these qualities may be controlled, and must be controlled, to get the various results desired in the different structural parts. In some cases, extreme hardness is required, even to the sacrifice of all else, as, for example, a razor or a surgeon's knife. In others, extreme softness and toughness are required, such as sheet metal that is to be pressed into intricate shapes; while in still other cases is required a maximum degree of strength in combination with the minimum degree of toughness that will prevent brittleness, such as the railroad locomotive spring or an automobile spring, and again the clash gears of an automobile transmission.

Heat Treatment More Important than Quality

Any combination or proportion of the three characteristics—hardness, strength and toughness—is possible through the proper selection of quality of steel, followed by proper sequence of heat treating operations. Neither one alone will do it all; but as between the two—treatment or quality—the heat treatment is the more important.

The foregoing statement may sound like heresy to many users of steel; but it is true to such an extent that the physical test (tensile strength) is no longer of great importance between seller and buyer of steel. This is particularly true with all steel that is to be forged or heated in some way by the user before the parts made by him are ready for delivery. Such heating completely changes the physical characteristics of the steel as purchased; namely, as to strength, hardness and toughness. It changes the size of the grain, and therefore the degree of refinement.

Many manufacturers who do not heat-treat parts produced but not used by them should do so for their own benefit, by reason of the improvement thereby brought about in the physical qualities of their output and the consequent safeguarding of their reputation. Such practice puts the need of physical requirements at the time of purchase of the original steel farther in the background.

Illustrations of the Need of Heat Treatment

On the other hand, some steel is shipped by the manufacturer in exactly the same condition physically as when received from the steel mill, and in this case the physical

test at the time of purchase is proper. It is also desirable after the part is finished and ready for actual use.

To illustrate: a plate in a bridge girder is in the same condition physically as when it came from the rolls. The rivets in that plate, however, are not. They may have been overheated (burned) with resulting coarse crystals and brittleness in place of the desirable fine grain and toughness, as found in the original rod stock. They have been highly heated twice; once when formed into rivets and once when driven into the plates, and when the whole is completed they may or may not be in good physical condition.

Consider the forged eye-bar of a bridge. It is tested carefully at the mill in the bar form, then heated to a very high temperature to form the eye, with the result that the portion of the bar that was heated may not be nearly so tough as shown by the tensile test on the original material. The grain has surely been coarsened; consequently, the steel can not resist fatigue as it should. All such important members should be heat treated to a definite physical condition, to obtain a predetermined elastic limit and a definite degree of toughness.

Government Specifications Contradictory

The United States Government specifications are curiously contradictory. For heavy ordnance they recognize to the fullest extent the importance of heat treatment and demand full knowledge of the materials in the condition they are to be used—a test on the finished product. In connection with the manufacture of small arms, and in general with miscellaneous parts of much importance, the matter of heat treatment is overlooked in a large measure. Specifications call for the use of bars of steel having certain elastic limit, elongation, etc., and it is then apparently satisfactory to permit this steel to be annealed, drop forged, hammered, welded, brazed, colored or pickled, with resulting marked changes of physical structure. There is no evidence to show the strength, toughness or hardness of the steel as found in the finished product.

The proper procedure would be to order steel of a predetermined composition, and to control the physical structure and characteristics of that steel by well regulated heat treatment. By so doing, the finished product might be brought to a definite strength, hardness or toughness perfectly suited to the work which it must perform.

Heat Treatment and Machining Operations

Another use of heat treatment in a shop is to control the difficulties of machining operations. In these days of economical shop management, there is nothing more important than "easy cutting" metals. This is under control in a very large measure by selection of the quality of steel and by heat treatment. Both are of importance.

Steel may be "hard to cut" for two reasons: because too hard and because too *soft*. With steel of the first class, the tool can not cut rapidly because the steel is hard and strong and the work done by the tool generates enough heat to dull a keen edge. This is a function of hardness as measured by elastic limit, or by Brinell hardness. A bar of steel heat treated to possess an elastic limit of 60,000 lb. per sq. in. may be very easy to machine; whereas if heat treated to possess an elastic limit of 100,000 lb. per sq. in., it will be very hard to machine with the same tools and speeds.

Of equal, or even more difficulty is the "too soft" steel. Here the tool can not cut rapidly because the steel is so soft and tough that it sticks on the cutting edge. This is followed by tearing of the metal, rather than cutting, and rubbing, so that heat is generated and the cutting edge is destroyed just as quickly, or more so, than with the really hard steel. Change of cutting speed will not help much, as in the former case.

The Treatment of Hard and Soft Steels

It is usually possible to soften a hard steel by suitable annealing, so that it will cut easily. It is not always possible to cure the soft "hard cutting" quality. It can be done in some instances, and without undue cost—if the shape and size of the bars or forgings permit—by a proper sequence of heating, quenching and annealing. The better way to overcome this difficulty is to avoid it by a proper selection of steel; to use a quality that is not likely to get into a "too soft" condition.

The screw manufacturer has appreciated this point for years and the steel purchased for stock screws has for its dominant characteristic easy cutting qualities. Strength and toughness are minor considerations.

On the other hand, certain very important parts of various machines are made of steel that "cuts hard" because it is really hard and strong. In this case the cost of machining is ignored; the strength and the hardness are all important. Such cases are extreme, however, and many of them might be avoided if proper steel in combination with proper treatment were used. Such practice is not common among steel users because many of the facts in the foregoing paragraphs are not fully appreciated.

Heat treatment should be known and understood by all users of steel whose output is of any importance as regards strength, toughness or hardness. This means nearly all users of steel. Spectacular results of extreme value are obtained in many cases; a high degree of improvement in most cases. "A little knowledge is dangerous", and the experience of some one who has been through the mill must be drawn upon or else heat treatment will meet with many setbacks.

The Selection of a Steel

A steel should be chosen with several phases of the problem in mind. The final choice is often a compromise between that which is ideal for a given duty and that which is best from a manufacturing standpoint. A steel that is to be welded can not contain certain alloys that make for high strength; as many alloy steels refuse to weld. A steel that is to be forged into difficult and intricate shapes should be modified as far as is safe, to permit of easy, commercial forging. Any steel may be forged for a price, but such price may be out of reason in view of the benefits to be obtained. There is little sense in spending a dollar in order to obtain a ten-cent benefit.

If the heat treatment must be done before finish machining, a steel must be selected that will machine easily in a suitable heat-treated condition.

Some parts of intricate form, with delicate portions, may not be treated after machining because of difficulties likely to ensue from warping. Other parts of simple form may be treated as a final operation, and a suitable steel may be chosen with this fact in mind.

Heat treatments, also, must be selected with reference to that which is commercial and practicable. Heavy pieces do not respond to heat treatment as sharply as light sections. Brine or water may have to be used in place of oil, in order to obtain certain desired results. But it is known that brine and water cause difficulty and greater percentage of loss due to warping than oil, and this point becomes an important factor. Temperatures also have to be modified somewhat in the same way. In theory this should not be so; but in practice it is so.

A steel that is to be case-hardened must be selected with such operation in view as well as for the duty it must perform. Whether the piece be thick or thin, heavy or light, makes some difference; and the heat treatment of a case-hardened piece must be modified accordingly.

All treatments come under certain metallurgical laws; but all must be modified to fit them to practical conditions.

The Overland Company, with a shipment of 90 machines, which left Toledo, Ohio, last week, on 30 flat cars of the New York Central, claims the record for any foreign consignment of American-made automobiles. The trainload, which is in addition to the regular exportations, was sent to eight different steamers and divided as follows: For Australia, 33; New Zealand, 15; Tasmania, 3; South Africa, 2; Brazil, 2; Holland, 2; Porto Rico, 7; Uruguay, 5; Peru, 2; England, 17, and the Philippines, 2. Each car was knocked down and crated.

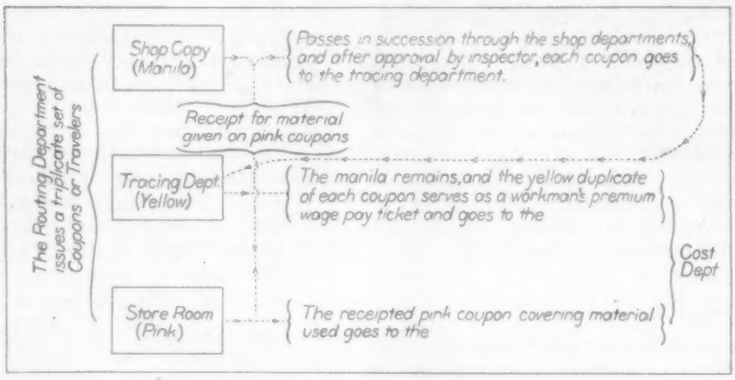
The statement of the Bureau of Statistics covering our foreign commerce for November shows another highly gratifying balance of trade in favor of the United States. The merchandise exports or the month exceeded the imports by $75,566,068. The total value of the exports was $201,747,560, against $206,620,377 in November, 1910. The value of the imports was $126,181,492, against $129,785,537 in November, 1910. For the eleven months of the fiscal year the exports exceed the imports by $475,029,282.

System in the Lodge & Shipley Machine Shops

A So-Called Traveler for Records of Progress of Work and of Time and Material—Premium Wage with Bonus to Foremen and Superintendents

BY HUGO DIEMER*

A number of articles have appeared in the technical press describing the shop methods of the Lodge & Shipley Machine Tool Company. The success of the company has been contributed to very largely by its progressive methods of handling problems of factory organization and shop systems. The policy of functional management is observed by the company in its staff organization. The president, Mr. Lodge, devotes his personal attention to the manufacturing programme. There is a so-called board of managers, consisting of the superintendent, the assistant superintendent, the head of the engineering department, the assistant manager and the head of the purchasing department, but this board is only in effect in the absence of the president. The vice-president, Mr. Shipley, looks after the sales and supervises also the purchasing, the head of the purchasing department having also in a general way control over stores and the clerical side of the cost and production departments.


The Routing Department issues a triplicate set of Coupons or Travelers
Shop Copy (Manila)
Passes in succession through the shop departments, and after approval by inspector, each coupon goes to the tracing department.
Receipt for material given on pink coupons
Tracing Dept. (Yellow)
The manila remains, and the yellow duplicate of each coupon serves as a workman's premium wage pay ticket and goes to the
Cost Dept
Store Room (Pink)
The receipted pink coupon covering material used goes to the

The Travels of the Traveler

Shop Orders

When it is decided to issue a shop order, the engineering department issues a parts list covering every item that goes into the manufacture of the particular device referred to. This parts list is sent with the drawings to the assistant manager. It is the duty of the assistant manager to have his assistant see whether all the pieces involved have had routing established for them. If the routing has not been established it will also be necessary to establish premium wage time standards as well as routing.

The general manufacturing programme of the company is adapted to the practice of manufacturing certain groups of parts which enter into various sizes and styles of machines. The engineering department keeps a record of the stock on hand of the different groups or units as they are designated by the company. It also has a record of the shop order numbers on which these groups or units are being constructed, and designates from what particular shop order number any particular shipping order shall be taken.

Material Lists

Separate material lists are written by the engineering department covering castings, bar stock, cut-off stock cut to standard lengths and standard screws, bolts, nuts, etc. The storeroom, on receipt of the bills of material, gets the material ready and puts it into boxes marked with the particular order number for which the material is intended.

The bill of material is sent also to the routing department. Here reference is made to routing records, which are kept in loose leaf binders in book form (see Fig. 1). The routing is in charge of a technically educated engineer with shop experience, who also has charge of the establishing of premium wage time standards and the somewhat lower "time limits." This position is one of the most responsible in the company and it is so recognized as its incumbent is designated by the title of assistant to president.

ROUTE—PREMIUM ALLOWANCE—TIME LIMITS

PC. NO. 972
PC. NO. SUB.
PC. NO. SUB.

NAME OF PART Headstock Spindle Thrust Washer.

DEPT'T LETTER	DEPT'T NO.	GROUP NO.	OPER. NO.	OPERATION	14"	16"	18"	20"	22"	24"	27"	30"	36" K	36" L	42"	48"
M	8	5	234	Bore & Face	13 Hr	14	14	14	15	15	15	28	30	30	30	30
				Time limit for above operation	9	10	10	10	11	11	11	16	20	20	20	20
				Time limit for above operation												

Fig. 1—Routing and Premium Record Showing Sequence of Operations, What Department Performs Operations and Premium Times and Time Limits. Kept in Loose Leaf Binders. Original, 6x10½ in. White Bond Paper

Shop No. 5802 Sym. 27/30 Pc. No. 977-3
Amt. Pcs. 20 Name S.P. Jaw.
Material ¾ CR. 2¼ x 8⅞
Tag Issued 8-1-1911 Mat. Issued
Mat. Insp. by Rec'd by
Wght. of Mat. at. Cost
REMARKS

Fig. 2—First Sheet of Traveler Book. This is an Order on the Store Room for the Material. Tough Paper, Approximately, 4¼x6 in.; Shop Copy, Manila Paper; Store Room Copy, Pink Paper; Tracing Department Copy, Yellow Paper.

Production System

The so-called tracing tag or shop tag or route tag, as it is variously designated in different shops, has undergone an interesting evolution at the Lodge & Shipley shops. In its present form it is a book of coupons which are in the first place in the form of large sheets for insertion into the typewriter. The typewriter operator copies the routing and premium records on the coupons while still in the large sheet form and afterwards cuts them apart and binds them at the left-hand edge in book form. About ½ in. is allowed for binding room at the left-hand margin. To the right of this binding space each sheet or coupon is perforated so that it may be easily removed from the assembled follower or traveler as the little book of coupons is called when they are all assembled and bound. Each of the sheets which are bound in this traveler is written in triplicate on dif-

*Professor of Industrial Engineering, Pennsylvania State College, and consulting industrial engineer.

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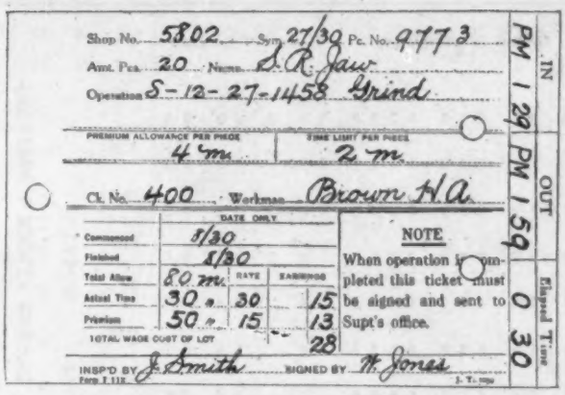

Shop No. 5802 Sys. 27/30 Pc. No. 9773
Amt. Pcs. 20 Name S. R. Jaw
Operation 5-12-27-1458 Grind
PREMIUM ALLOWANCE PER PIECE 4 m.
TIME LIMIT PER PIECE 2 m.
Ck. No. 400 Workman Brown H.A.
DATE ONLY
Commenced 1/30
Finished 1/30
Total Allow 80 m.
Actual Time 30 m. 30 15
Premium 50 m. 15 13
TOTAL WAGE COST OF LOT 28
NOTE
When operation is completed this ticket must be signed and sent to Supt's office.
INSP'D BY J. Smith SIGNED BY W. Jones
IN PM 1 29
OUT PM 1 59
Elapsed Time 0 30

Fig. 3—Operation Coupons of Traveler, Serving Also as Time Ticket and Cost Record; Colors and Dimensions Same as Fig. 2

ferent colored slips, manila being the shop copy, yellow the tracing department copy and pink the store-room copy. Each set of these sheets covers a distinct operation, and the whole book includes material receipt and a complete list of all operations arranged in the order in which the operations are to be performed.

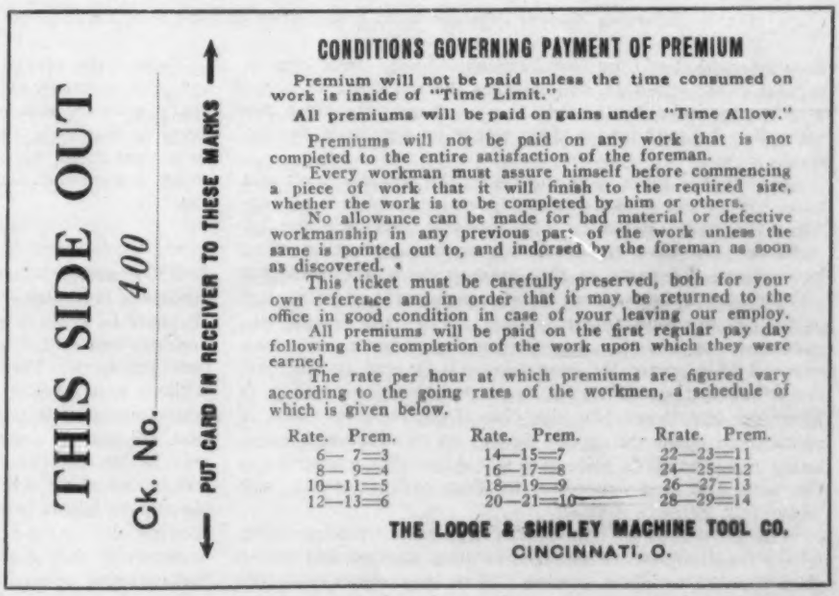
One of the sets is sent to the tracing department or table, where it remains on file, in the form of separate operation sheets, each individual operation sheet remaining in the tracing table files until the shop copy of the same operation on that piece is sent from the inspector to the tracing department. When this arrives at the tracing department it is substituted for the tracing department's copy, which is then sent to the cost department. Thus the tracing department slips show the rate of progress made by the shop on the various operations on each piece. There can be no side-tracking of the tracing department, since the shop slip is also the individual workman's premium-wage pay-ticket and must pass through the hands of the inspector and the tracing department before the pay-roll department will approve the premium pay.

Another set of the traveler slips goes to the stores department and remains there until the various departments want their particular work. A third set is distributed to the various foremen who have to do the first operation.

The traveler book is started by writing out the name of the part from the blue-print material lists. The routing is obtained from the routing and premium record (see Fig. 1), also the premium time standards and the lower time limits, which are all inserted on the proper slips.

The first removable slip in the traveler book is an order on the store-room for the material. (See Fig. 2.) Then come the operation coupons in the sequence in which the work is to be done. (See Figs. 3 and 4.) When the various coupons have all been written they are cut apart. Then the cover is put on, the color of the cover and bold face lettering indicating whether the order is a stock order or a shipping order or a repair order. (See Fig. 5.) The book is then stitched with metal by a small binding machine, the shop set on manila paper being sent to the department having the first operation to do; another copy on yellow paper being sent to the tracing department, this copy being unbound, and a third copy on pink paper going to the store-room.

When the foreman of the department doing the first operation wishes the material he sends to the store-room for it and signs the material coupon as having received the material in good order. The store-room in many instances send out material when they are confident the department is ready to accept it.


THIS SIDE OUT

Ck. No. 400

PUT CARD IN RECEIVER TO THESE MARKS

CONDITIONS GOVERNING PAYMENT OF PREMIUM

Premium will not be paid unless the time consumed on work is inside of "Time Limit."

All premiums will be paid on gains under "Time Allow."

Premiums will not be paid on any work that is not completed to the entire satisfaction of the foreman.

Every workman must assure himself before commencing a piece of work that it will finish to the required size, whether the work is to be completed by him or others.

No allowance can be made for bad material or defective workmanship in any previous part of the work unless the same is pointed out to, and indorsed by the foreman as soon as discovered.

This ticket must be carefully preserved, both for your own reference and in order that it may be returned to the office in good condition in case of your leaving our employ.

All premiums will be paid on the first regular pay day following the completion of the work upon which they were earned.

The rate per hour at which premiums are figured vary according to the going rates of the workmen, a schedule of which is given below.

Rate.	Prem.	Rate.	Prem.	Rrate.	Prem.
6—	7=3	14—15=7		22—23=11	
8—	9=4	16—17=8		24—25=12	
10—11=5		18—19=9		26—27=13	
12—13=6		20—21=10		28—29=14	

THE LODGE & SHIPLEY MACHINE TOOL CO.
CINCINNATI, O.

Fig. 4—Reverse of Shop Copy of Fig. 3. Not Reproduced Strictly as to Style of Type

The individual operation slip serves also as a routing slip and premium ticket. When sent from one department to the next in the form of the traveler it serves as a job ahead record. The individual slips serve as time tickets when torn out and stamped on the elapsed time clock by the workingman. When taken from the box under the clock where it is deposited by the workingman it serves as a notice to the inspector that the work is ready for the inspection of the operation indicated. When sent by the inspector to the tracing department it serves as an indication that the operation has been satisfactorily performed.

The men themselves stamp the individual operation slips. As the men do not know what the next job is to be there is less possibility of favoring the time on one job at the expense of another than there might be if the stamping of the tickets were to be done by the foremen. Each clock-stamp has a finished-job box under it, and each operation slip is removed by the workman from the follower or traveler book as that operation is completed by him and by insertion into the time clock, the clock stamps not only the beginning and completing time, but also the difference in time or the elapsed time in plain arabic numerals. The workman then puts the slip into the slit in the box.

It is now out of the foreman's hands and in charge of the inspector who also supervises the moving of work from one department to the next. The inspector piles up all the parts to be moved from one department to the next, the transferring being done by storage-battery-driven auto-trucks, of which there are two in the factory, each one doing as much work as could be

SPECIAL

FOR ORDER No. 11537

ATTENTION!!

THIS TRAVELER IS A SHOP RECORD. PLEASE KEEP IT AS FREE FROM DIRT, OIL, ETC., AS POSSIBLE. IT MUST ALSO ACCOMPANY JOB THROUGH SHOP. IN ORDER TO DO THIS SEE THAT IT IS FASTENED TO THE FIRST PIECE THAT YOU DO.

THE LODGE & SHIPLEY MACHINE TOOL CO.

Fig. 5—Cover of Traveler Book, Not Reproduced Strictly to Style—Dimensions Same as Fig. 2

12	10	1 3	Dept.	Man	Charge		Piece No.		Group	Operation		Hours		Amount		
11	11	2 4														
10	Wk.	Day	0 0	0 0 0		0 0 0 0	0 0	0 0 0	0 0	0 0 0	0 0 0 0	0 0	0	0 0	0 0	
1	1	1 1	1 1	1 1 1	Std	1 1	1 1 1	1 1	1 1 1	1 1	1 1 1	1 1 1 1	1 1	1	1 1	1 1	RH
2	2	2 2	2 2	2 2 2	Rep	2 2	2 2 2	2 2	2 2 2	2 2	2 2 2	2 2 2 2	2 2	2	2 2	2 2	OH
3	3	3 3	3 3	3 3 3	Tls	3 3	3 3 3	3 3	3 3 3	3 3	3 3 3	3 3 3 3	3	3	3 3	3 3	Prm
4	4	4	4 4	4 4 4	N Pt	4 4	4 4 4	4 4	4 4 4	4 4	4 4 4	4 4 4 4	4		4 4	4 4	Pro
5	5	5	5 5	5 5 5	A Pt	5 5	5 5 5	5 5	5 5 5	5 5	5 5 5	5 5 5 5	5		5 5	5 5	RSp
6	+	6	6 6	6 6 6	Drw	6 6	6 6 6	6 6	6 6 6	6 6	6 6 6	6 6 6 6	6		6 6	6 6	RDf
7		7	7 7	7 7 7	M M	7 7	7 7 7	7 7	7 7 7	7 7	7 7 7	7 7 7 7	7		7 7	7 7	NP
8		8	8 8	8 8 8	ShX	8 8	8 8 8	8 8	8 8 8	8 8	8 8 8	8 8 8 8	8		8 8	8 8	
9		9	9 9	9 9 9	CmX	9 9	9 9 9	9 9	9 9 9	9 9	9 9 9	9 9 9 9	9		9 9	9 9	

1703 LABOR Form T-34 200M THE LODGE & SHIPLEY MACHINE TOOL CO.

Fig. 6—Tabulating Machine Punch Card for Transcription of Records on Fig. 3. Approximately 3¼x7½ in. Manila Card

accomplished by four hand-trucks. Each truck has a regular route schedule, and it takes the truck-driver about 45 min. to make his rounds in the shops. He rings his bell when he gets into a department to announce his arrival.

The trucker takes with the pieces the traveler book and takes pieces and books to the department which is to perform the next operation. The foreman receiving the lot signs the slip covering the last preceding operation when he receives the parts in this manner from the inspector and auto-truck driver, and his signature serves as a receipt in the tracing department records. When the tracing department receives this slip the tracing department's own copy of this particular operation slip is sent to the cost department. Here it serves as a cost record as well as a premium pay ticket. In the cost department the slip is transcribed by punching out figures on the Hollerith tabulating machine card. (See Fig. 6.) After this transcription the slips are filed according to shop order number, and under that by piece number.

The third copy or triplicate is kept on the tracing table, where these copies are assorted to shop number and under shop number by piece number. Here they serve as a record for the tracing clerk, enabling him to know the location of each piece, and what work is still to be done on each piece. When the actual traveler operation ticket comes to the tracing department it takes the place of the triplicate. The triplicates are then sent to the cost department.

The store-room copy, when sent in to the cost department from the store-room, shows that the material is in stock and has been charged by the store-room to the proper shop order number by the punching out of a Hollerith tabulating machine card.

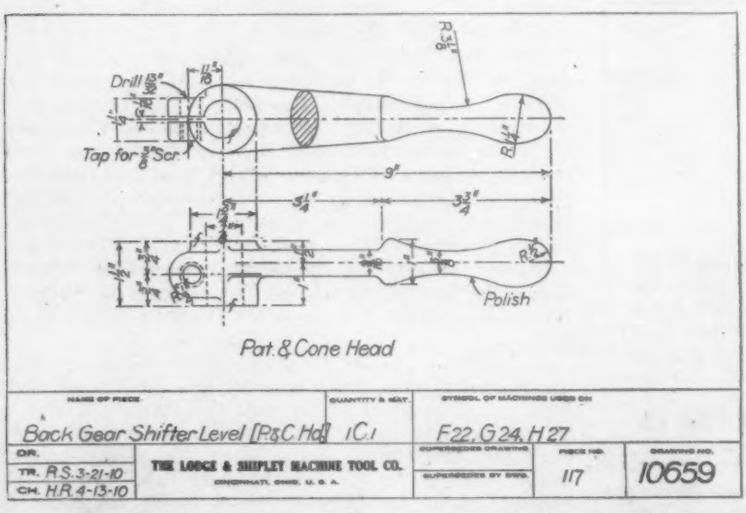


Fig. 7—Shop Blueprint Gummed to Inside Cover of Traveler, Approximately 6x8½ in.

Before the traveler book is sent from the production and cost department to the store-room, it is sent to the drafting-room, where a small blueprint of that particular piece, giving only the information needed for doing the shop operations on that piece, is pasted into each book along a gummed edge on the inside of the cover. (See Fig. 7.)

Tracing Department

The tracing department has a number of tables accommodating card index boxes, in which the slips representing all parts in process are arranged, first according to order number, and under order numbers according to individual part numbers. These boxes are arranged side by side, without tops, so that any part can be reached instantly. As stated, each workman, as soon as he has finished an operation, stamps his operation slip, which he tears out of the traveler book on the elapsed time clock and puts it in the box under the clock. The only person who has a key to open these boxes is the inspector. The inspector, after approving the lot and securing the receipt signature of the foreman of the department doing the next operation, sends the approved operation slip to the tracing department. The tracing department clerk exchanges the shop copy for his regular tracing department copy, sending the latter to the cost and premium department. This shows that it is all right to pay the premium, if any.

In addition to these slips in the tracing department, which show the state of completion and progress of each piece, there is a large blackboard in the department, on which are shown the various parts and their state of completion, on the four lots of standard machines nearest completion in the shop. The record on this blackboard is a mere duplicate of the record on the slips, but it is assembled and visualized in a form in which the superintendent and foremen can see at a glance what is holding any one of the four orders.

At the time of my visit 260 separate jobs were on the tracing board. The assistant manager has charge of the tracing. The department employs one clerk and two tracers, besides the operators of the electric storage battery auto-trucks. One tracer is employed on standard work and one on special and repair orders.

The department maintains also a set of numerically arranged cards defining the various shop orders, these cards being set side by side in vertical racks at the back of the tables on which stand the boxes holding the individual operation slips on the various pieces. In this way the clerk is always facing the cards defining the various live shop orders.

In the erecting departments small black-boards are fastened overhead, be-

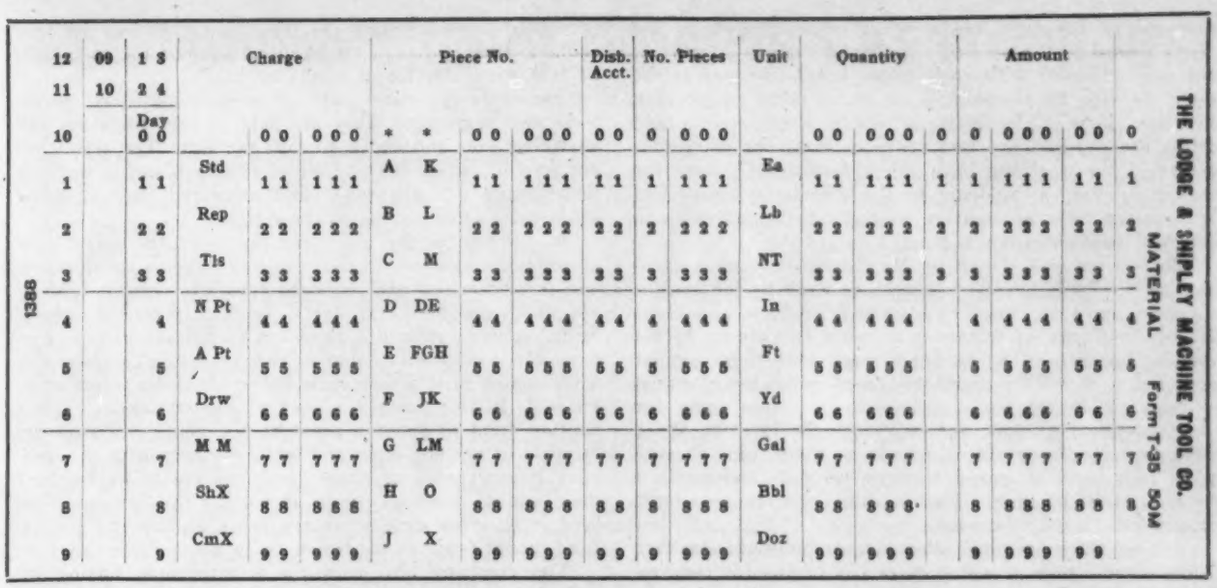


Fig. 8—Tabulating Machine Punch Card for Transcription of Store-room Records of Receipts and Disbursements. Dimensions same as Fig. 6. Pink Card for Disbursements. Green Card for Receipts

ing suspended by screw-eyes from wires so that they can be shifted along these wires to spaces above certain erecting work on the floor. These little black-boards designate what is yet to be done on the job and state time of shipment required.

Time and Cost Records

For many years the company has adhered to the weekly time-sheet with entries made by time-takers going through the shop. This weekly time-sheet was adapted with a great deal of ingenuity to use with the Hollerith tabulating machine. Not only weekly returns and consequent checking with pay-roll have been maintained, but daily returns have been brought about by each time-taker turning in a part of his time sheets at a certain time each day to the clerk punching the tabulating-machine cards from the time-sheet entries. Within the last few months, however, the company has installed the elapsed time type of International time clock with electric master-clock and magnetic time stamps in the shops, as heretofore indicated.

When the store-room places material into the proper box for a designated shop order, a red disbursement card is punched out for use on the Hollerith tabulating machine. which gives the money value to date of material issued to shop on work in process. (See Fig. 8.) A similar tabulating-machine card in green is prepared to cover each item of goods received, and serves as a basis for calculating up to date the money value of all stores received.

The tabulating-machine methods of the company are quite fully described in the American Machinist of March 16, 1911. For the benefit of those who are unfamiliar with the working of this equipment a few explanatory remarks may be advisable. In order to use a working-card in the tabulating machine it is necessary to designate everything numerically, the record being formed by punching the digits in columns of figures printed on a card, such punching being done by a special machine. The punching may be done as a transference of records taken originally in pencil or from elapsed-time clock stamps on a time-ticket. The punched tickets are put first into an assorting machine which classifies them by the same numbers in any one column, for instance, time tickets may be assorted by departments, by operations, by men, by order numbers, etc., depending upon which column is being used for the purpose of assorting. After the assorting process is accomplished at a very rapid rate by the machine the cards are transferred to the accumulating or adding machine, which adds up the hours and minutes or dollars and cents for any package of cards.

Premium Wage System

An interesting feature of the premium wage system is the sharing of the foremen as well as the superintendent and assistant superintendent in the premium gains earned by the men. It must be borne in mind that Cincinnati was one of the earliest centers to make use of the premium wage system, and the system has had the advantage of plenty of time for its perfection. After some ten years of experience with the system, the Lodge & Shipley Company has decided that gain-sharing should be participated in by the foremen and factory superintendent and assistant superintendent. These officials share in all gains

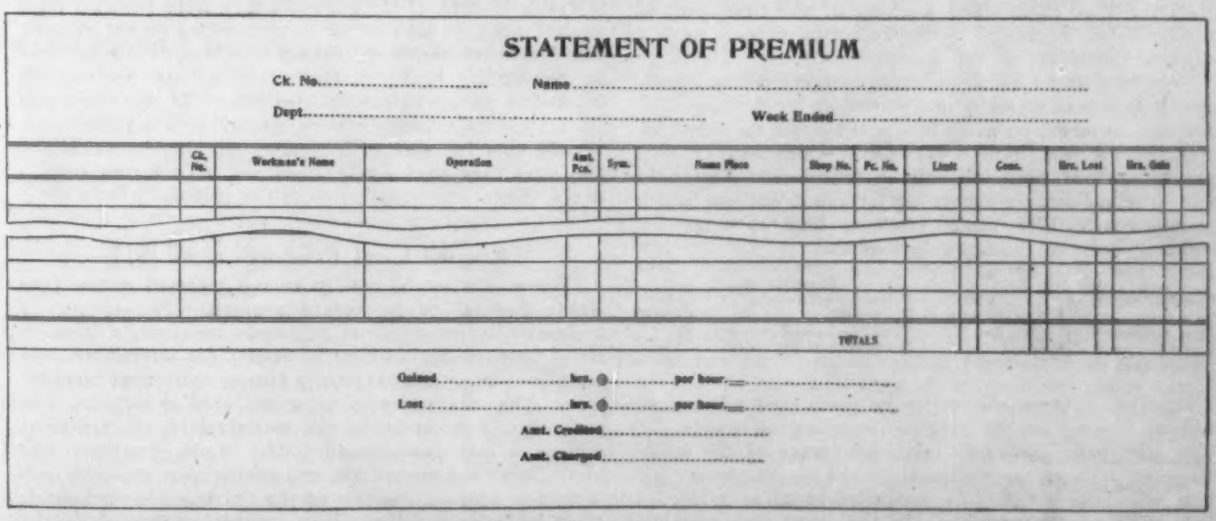


Fig. 9—Premium Record, Arranged by Departments. White Original Remains in Cost Department; Yellow Copy for Foreman; Pink Copy for President; 12x12 in., Bond Paper, Ruled in Red and Blue

that reduce the time below what is designated as the "time limit." Also the officials' bonus fund is not only credited with such gains, but is debited at the same rate for all premium work which takes longer than the time limit. The rates at which these credits and debits are charged are two cents an hour for each hour gained by the workman in any department and 5 cents for each hour lost, as applying to the foreman's bonus, and ¼ cent per hour as applying to the superintendent's and assistant superintendent's bonus.

The writer was shown by Mr. Lodge the bonus earnings on this basis made from week to week by the various foremen, and they varied in amount from $2 to as high as $18, the majority of instances showing an earning by the various foremen of $5 to $10 a week over their regular pay. Fig. 9 shows the premium record, which is written out in triplicate in the cost department, one copy being for the department records, one copy for the foreman and a third copy for the president, who keeps these "pink sheets," as he calls them, in bound form on his desk and makes a constant study of them. Fig. 10 shows the reverse of the copy handed to the foreman.

The so-called premium allowance or premium standard is the outside time at which extra pay begins for time reduction. The time-limit is a lower time, representing the time within which work must be done. If the workman cannot make the "time limit" on the first four pieces of a lot he must ask the foreman to show him how to make the time; and at the same time the failure to go below the time limit or reach it is a charge against the foreman's bonus, provided the man was working on four pieces or more. If less than four pieces were worked on no charge against foreman's bonus is made by reason of failure to attain the time limit. The working of the time limit is perhaps better explained by the following extract from a notice to employees by Mr. Lodge:

CONDITIONS GOVERNING PAYMENTS

No work will be paid for that is not completed to the entire satisfaction of the Superintendent or his representative.

Every foreman must assure himself, (before allowing the workman to start a job) that the piece of work will finish to the required size, whether the work is to be completed by him or others.

No allowance can be made for time put in on defective material past the point where the defect should have been discovered. This is to be decided by the Superintendent or his representative.

No allowance can be made for defective workmanship.

All payments will cover a period of one month.

It is not permissible that the average wage rate per hour in your department be allowed to increase. Each foreman is expected to maintain the normal average wage rate per hour in his department.

Information on anything pertaining to this system not clearly understood can be obtained by applying to the Cost Department.

The Lodge & Shipley Machine Tool Co.

Fig. 10—Reverse of Foreman's Copy of Fig. 9

"We must insist on all premium workers taking advantage of improved methods and conditions to increase their earnings. In order to make this possible, we have decided to establish a time limit on each piece, which must be lowered before any premium will be considered. This time limit is in no sense a record performance, but one which can be comfortably made, ensuring high earnings for workers. See two examples here given:

Example No. 1	Example No. 2
Premium allowance ..... 1 hr.	Premium allowance ..... 1 hr.
Time limit .....30 min.	Time limit .....30 min.
Time consumed on job..20 "	Time consumed on job..40 "
Operator's gain and premium paid on.....40 "	No premium earnings.

"Further savings will easily be made, and all savings paid as before, on the original premium allowance. To those who have previously taken advantage of the possibilities of high earnings this will make no difference, and those who have not, will be compelled to do so or forfeit their right to any premium. In the event that premium workers, *from any causes beyond their control,* should be prevented from lowering the time limit, they can put in a claim to their foreman for readjustment of the time limit of that particular lot of pieces or job."

The bell-boys were put on a premium pay system some two years ago. They are paid ½ cent for every call answered over and above 50 calls per day. The result has not been to reduce the number of bell-boys, but to increase the number of calls made and answered. and to bring about more effective use of the system.

In addition to the 2½ cents per hour for every hour of premium gain which the company pays to the foremen and superintendent and assistant superintendent, a fund of 2½ cents per hour for every hour of premium gain is being set aside toward a fund for an old-age pension system. Mr. Lodge states that in two years the company has accumulated in this way some $7,000. It is his intention to set aside in this manner a fund of $300,000 as an old-age pension fund to provide pensions for employees who are 65 years of age and over, and who have been with the company twenty years or more, their pension to be one-half their annual earnings while at work. The company has been in business some seventeen years, so that the pension fund would begin to be drawn on in about three years.

The company also uses the telautograph, having installed eight transmitters and receivers. By the use of this instrument a foreman can write out a requisition on the store-room, and a copy will simultaneously appear at the store-room and in the cost department at the desk of the official who is to approve the requisition. The approval then appears at store-room and foreman's desk when written by this official. The instrument is also used for interdepartmental messages.

In many respects the cost and tracing systems are about as automatic and interlocking as could be devised.

British Iron and Steel Exports and Imports

The statement of exports of iron and steel from Great Britain in November shows a total of 437,666 gross tons as against 395,298 tons in November, 1910. The increase is something over 10 per cent. However, for the entire year 1911 the exports will probably fall somewhat short of those for 1910. For the eleven months ending with November the total was 4,241,911 tons, as compared with 4,354,434 tons in the first eleven months of 1910. The value of the exports last year is somewhat greater per ton than in 1910, the total for the eleven months being £40,435,080, against £39,829,712 for the first eleven months of 1910. Rail exports have fallen off considerably, the total for eleven months in 1911 being 331,664 tons against 428,147 tons to November 30, 1910. Tin plate exports were 450,000 tons last year to November 30, against 445,000 tons to November 30, 1910. Shipments to the United States fell off to practically nothing in November, the total being 321 tons against 4904 tons in November, 1910. The total tin plate exports to the United States were 13,633 tons for eleven months last year against 70,977 tons to November 30, 1910.

Great Britain's imports of iron and steel increased considerably in 1911. For 11 months they were 1,650,398 tons, against 1,282,355 tons in the corresponding period of 1910. For November they were 163,546 tons, against 133,117 tons in November, 1910. A large part of the increase to November 30 was in semi-finished steel. In sheet bars and tin plate bars the totals were 290,641 tons for 1911 and 177,465 tons for 1910 to November 30. In blooms, billets and slabs they were 440,123 tons and 285,728 tons respectively.

Record Coal Production in 1911

The production of coal in 1911 is reported by the Coal Trade Journal to be record-breaking. The output of anthracite is estimated at 90,300,000 net tons, a gain of about 6,000,000 tons, while the figures for bituminous coal are placed at 125,000,000 tons, a gain of more than 7,000,000 tons. The total value is estimated at $637,000,000. The pessimistic note in trade and manufacture affected bituminous values considerably. The trade, however, was much improved toward the end of the year, and the outlook for 1912 is considered favorable. The anthracite trade is declared to have been prosperous throughout the year.

The Human Side of Business Organization

BY STERLING H. BUNNELL

The idea is frequently presented that the successful organization operates as a smoothly working machine. From the point of results, this is undoubtedly true. But with regard to the machine itself, the simile leaves much to be desired. The parts of a machine are essentially rigid, as gears, rods and shafts; their flexibility is in general a detriment rather than an object (except in the case of springs). In the machine composed of human beings, the parts cannot be said to be rigid, to operate along hard and fast lines, or to represent the firm and unyielding elements of a mechanism. Success in organization comes only to those who take advantage of the flexibility of the component parts.

The organization as distinct from its separate individuals must first of all work together for a common end, even though each of the members has his own ideas and desires, and must naturally, as the saying is, "look out for number one." It is the manager's task to harmonize these conflicting objects, so that each man may see that in working for his own best good he is advancing the interests of his organization.

Relations with Associates

Loyalty to the organization idea cannot be expected of employees without friendship or without confidence in each other's ability. One successful manager says that if he is in doubt as to the desirability of a member of his force, he sometimes asks frankly of other members their opinion of the man in question, whether he should be retained or dismissed; and then invariably abides by the decision of the majority. Broadly considered, this viewpoint seems to be reasonable. If a man has so far missed his vocation as to be unable to merit the regard of his associates, he can hardly be useful as a member of an organization.

The dual viewpoint of each man is always to be kept in mind. Presumably every man in the organization is faithful to his ideals as he knows them, and is also self-interested. It is impossible to expect success from the services of a man who is not working wholeheartedly for his own best interest. If the manager cannot reward his employee by an increase in salary when requested, he had better dismiss the man than allow him to stay with a dissatisfied feeling. If a man is worth keeping and is not worth the increase he asks, it is absolutely necessary that the manager shall convince him that his best interests lie in remaining and that his best efforts will be rewarded as generously and as soon as possible. A full explanation of conditions rarely does any harm and usually does very much good in a case of this kind.

The personal element in the relation between manager and employees is always to be kept in sight. However, employees should by no means imagine that the only diplomat in the force is the manager. Managing ability is developed before the manager is appointed; and the employee who can live with his fellow-workers on a footing of cordial friendship, carefully avoiding the appearance of adopting another's ideas without credit or of playing for an undue share of credit himself, can feel that he is in line for a managing position in the near future.

Employees' Suggestions

Much of the valuable advice and suggestions which go to making a business great come from employees often ranking far below the chief. The treatment of suggestions cannot be too carefully studied. Naturally nine-tenths of the ideas for improvements in ways of doing work which occur to a resourceful man are worthless, or at best of small value. The man with trained judgment eliminates for himself the schemes which seem to his second thought as "crazy," and gives attention to a comparatively few which stand the test of a second or third study. The man of untrained judgment will bring to light a far larger proportion of suggestions which have no practical value; and yet even this man may produce a percentage of good ideas. By dismissing suggestions abruptly and without apparent consideration, the source of supply is stopped and the impression goes about that the chief has no regard for the ideas of any one but himself. On the other hand, a tactful man will receive and entertain with respect all the suggestions that are made to him, and will turn down the impracticable ones in such a way that the originator will appreciate that his idea and not himself was at fault. It is very easy to handle a resourceful man who suggests impracticable schemes by suggesting in return the difficulties of these schemes and leaving them for him to surmount.

In general, the manager's continued object should be to draw out as much interest and attention from his subordinates as possible. No return is likely to come to the business except from effort. As far as employees can be induced to think, study and work for their own interests, the interest of the employer will be advanced. It should be possible for the employer to interest the members of his organization to such an extent in the work they are doing as to induce them to advance themselves in it, rather than to go outside the lines in which they are at work and direct their efforts apart from working hours in other directions. Few successful men limit their activities to definite business hours, whether these are long or short. It is only the apparent refusal of employers to offer more than a stated minimum wage for a definite period of time per day that induces so many men to branch out from the work on which they are employed and in which they would be successful, to side issues of various kinds. A man who is a freight clerk in the daytime and a draftsman at night has divided his efforts between two entirely different objects. If the employer will appreciate that the efforts of the earnest worker are often given outside of working hours to some probable means of bettering his condition he will take care to make the worker's future in the business so attractive and so clear as to occupy his entire attention. It is hardly necessary to suggest the profit-making advantages of an organization, all of whose members are working all of their time to one common end, in which each sees his future assured.

The Development of Alaska's Resources

Judged by the large advance in Alaska's mineral production in 1911, as estimated by Alfred H. Brooks, of the United States Geological Survey, over the output for 1910, mining activities in the last year have actively increased. This improvement is apparent notwithstanding the continued tie-up of all Alaskan coal, the development of which would, it is believed, give a greatly added impetus to the Territory's various industries. The fuel demand is being partially met, however, by the use of fuel oil.

The value of Alaska's mineral production for 1911 is estimated at $20,370,000. Of this amount $17,150,000 is to be credited to gold production, against $16,128,749 for 1910. Mr. Brooks further estimates that the Alaska mines produced 22,900,000 lb. of copper in 1911, or more than five times the Alaska copper output of 1910, which was 4,241,689 lb. In addition to gold and copper, Alaska mines and quarries in 1911 produced silver, tin, coal, marble, and gypsum to an estimated value of $390,000, an increase of over $200,000 as compared with their value in 1910.

The total value of Alaska's mineral production since mining first began in 1880 is, in round numbers, $206,000,000, or more than 29 times the sum paid to Russia for the Territory's various industries. The fuel demand is being value of the gold production.

Aside from the increased mineral production, the most important event of the year was the opening of the Copper River region by the completion of the railroad into it. The industries already stimulated by this line strikingly illustrate the importance of railroad communicaton to Alaska. At the close of 1911 there were 465 miles of railroad in the Territory, compared with 371 miles in 1910. This mileage is distributed among 9 different lines from 5 to 196 miles in length. The most urgent need is for a railroad to connect an open port on the Pacific with the Yukon basin. Until such a line is built only the richest placers of the interior and only the most favorably located lodes can be profitably exploited.

Accident Prevention in Steel Plants

Safeguards for Blast Furnaces and Rolling Mills, for Metal and Wood-Working Machinery and for the Foundry, Power Plant and Railroad Yard — Cooperation of Employees

BY ROBERT J. YOUNG*

At the last meeting of the Association of Iron and Steel Electrical Engineers, the author presented a paper on practicable safeguards and methods of preventing industrial accidents. On the basis of that lecture, the following review of the subject has been made:

The care exercised by the workman largely enters into the number of accidents occurring in any department, and the only way the number of accidents due to carelessness can be reduced is by the inculcation of habits of caution into the minds of the men. The burden of doing this must rest almost entirely upon the management of a department. The superintendent's attitude and the foreman's attitude toward the prevention of accidents will be reflected by the workmen just as accurately as their attitude toward the getting out of tonnage is reflected. If the superintendent treats the matter lightly, his assistants will treat it lightly. If he shows a strenuous desire to have working conditions safe and precautionary rules observed; if he makes the prevention of accidents one of the most important features of his department; then his foremen will reflect that feeling and will see that the men observe the precautions which are known to be necessary to the prevention of accidents. By seeing that the men observe these precautions and by talking with them about the necessity of keeping conditions safe, they will inculcate such habits of caution that the number of accidents occurring in that department will be reduced to a minimum.

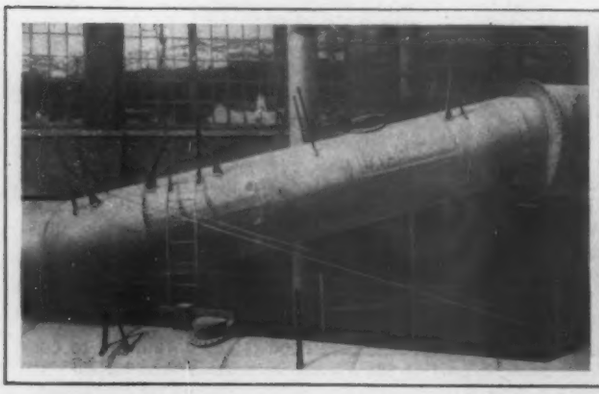
Among the subsidiary companies of the United States Steel Corporation, the one which has probably been the pioneer in accident prevention is the Illinois Steel Company.

For a number of years the subsidiary companies of the United States Steel Corporation has been carrying on a campaign for the safeguarding of machinery and other dangerous places. In the month of May, 1906, Mr. Charles MacVeagh, general solicitor of the United States Steel Corporation, called a meeting of the casualty managers of the subsidiary companies to be held at his office for the purpose of considering ways and means of preventing accidents and making working conditions safer. Two days were devoted to the discussion. In May, 1908, Mr. MacVeagh again called a meeting of the casualty managers for the purpose of considering the results of the attempts which had already been made to prevent accidents and to consider and formulate further plans for the safeguarding of employees.

The Steel Corporation's Committee of Safety

One of the results of this meeting was the appointment of a Committee of Safety. Inasmuch as this was, as far as I know, an entirely new thought, it may be well to give a short description of the work of this committee. The committee is composed of the general solicitor of the United States Steel Corporation, Mr. MacVeagh, who acts as chairman; a safety engineer having general supervision over safety matters in the corporation, Mr. C. L. Close, who acts as secretary, and seven members, each one being a representative of some one or more of the subsidiary companies of the United States Steel Corpora-

*Safety Inspector, Illinois Steel Company.



Hand Lines on Tops of Gas Pipes and Chained Weights on Explosion Doors

Walk Between Tracks on Trestle and Hand Railings with Guard Plates at Base

tion and engaged in safety work. This committee meets quarterly and its functions are as follows:

1. The committee conducts thorough inspections of all plants of all subsidiary companies from the standpoint of safety. These inspections are in addition to those made by the companies themselves, and are conducted by inspectors selected from companies other than those operating the plants in question. These inspectors report and are responsible to the safety committee and not to the companies whose plants are under inspection. From time to time, and whenever special circumstances seem to require such action, the committee, or various members thereof, make these inspections themselves.

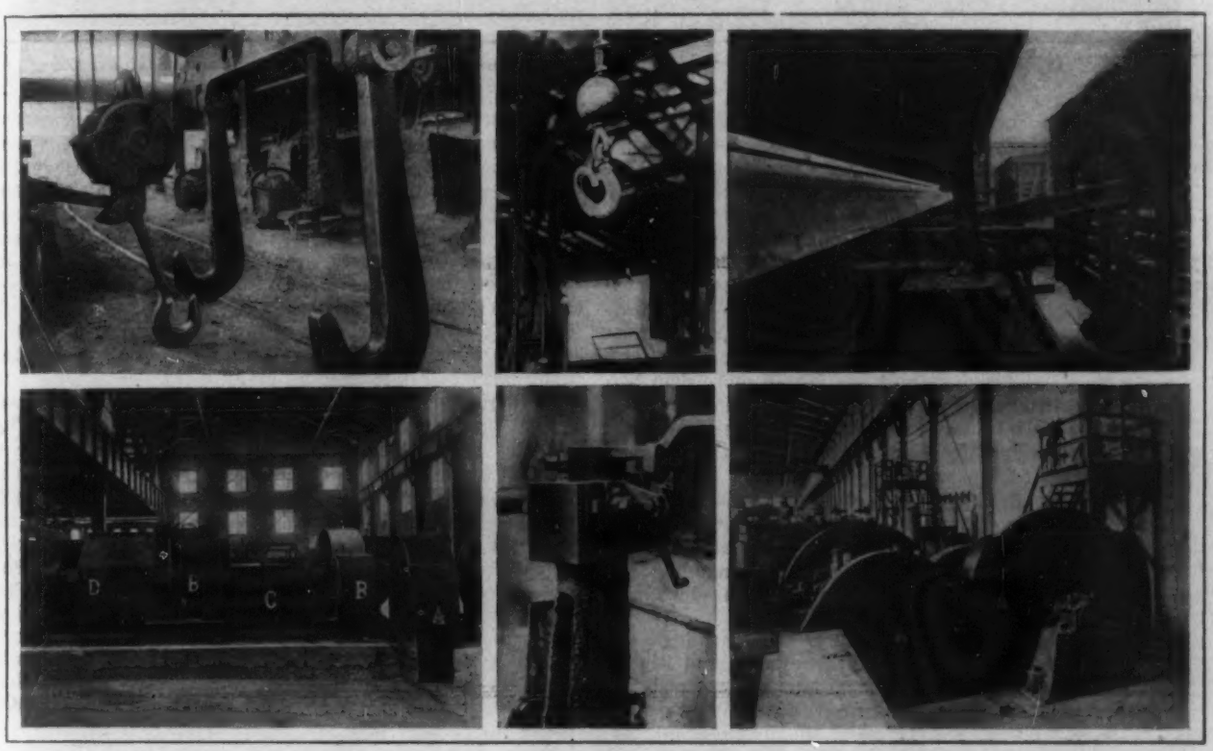
2. The committee acts as a clearing house for all information relating to the safety of employees. All safety devices and other methods of increasing the safety of the workmen and of interesting the men in their own safety and that of their fellow-workmen are reported to the committee by the subsidiary companies in which they originate. These safety methods and devices are carefully considered by the committee and, if approved, are recommended to all the subsidiary companies, often with improvements suggested by the committee. In this manner descriptions with full details, photographs, diagrams and complete information of all matters dealing with the safety of employees is disseminated among the subsidiary companies.

3. The committee at its quarterly meetings considers all serious accidents which have occurred in any of the companies during the preceding quarter with a view to devising means for preventing the recurrence of similar accidents.

4. In addition to its work for the prevention of accidents the committee assists in the administration of the Voluntary Accident Relief Plan and considers any questions of general character which arise in the administration of the plan.

The committee is endeavoring now to standardize these safety devices which are in use upon machinery common to a large number of the different plants. It is hoped thus to insure the use of only the most improved and effective safeguards. As a further help in familiarizing the superintendents and foremen of the different plants with the safety devices approved by the committee, a Safety Bulletin is issued periodically, showing engravings of safeguards and working drawings of devices with a full description of their operation.

My further remarks and the views of safety devices will necessarily be confined largely to the work being done by the Illinois Steel Company for the prevention of accidents at its several plants. It is obvious that the industrial plant which would seriously take up the problem of accident prevention must undertake (1) to provide and maintain proper working conditions and efficient safeguards, and (2) to educate its employees and inculcate in them habits of caution. This, of course, requires a definite plan and a comprehensive organization to carry out such a plan. In handling this work the Illinois Steel Company has divided it into three closely allied headings: The safeguarding of dangerous places; the promulgation of rules for safe operation, and the inculcation of habits of caution in the minds of all concerned.



Hook for Tipping Ladle for Pouring When It Reaches Pouring Position

Pig-tail Hook for Pouring Ladle Stoppers

Guards to Hold Material from Falling from Loading Beds

Guards Over Gears and Couplings at Cambering Machine

Locking Device for Machine starting Lever

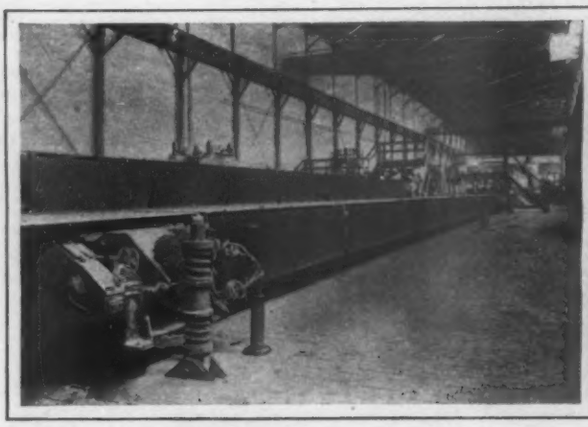
Gear and Flywheel Guards for the Rail Mill Bloom Shear

The Safeguarding of Dangerous Places

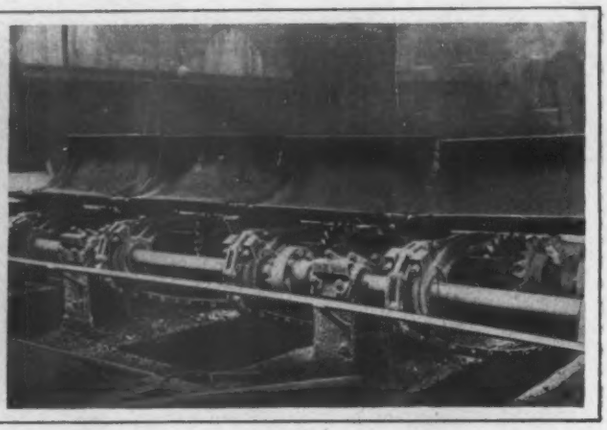
It might be said in this connection that although statistics show that failure to guard dangerous places is not the most prolific source of accidents, carelessness in this regard has a most marked effect, consciously or unconsciously, upon our thoughts and actions, and is, therefore, conducive to reckless habits. What folly it would be to try to enforce rules or train the workmen into thinking of their own and others' safety if we did not show our desire to prevent accidents by doing all in our power to make working conditions as safe as possible.

The Illinois Steel Company operates five plants—each plant covering many acres and employing thousands of men. The plant at South Chicago, for instance, covers about 400 acres, and, when running full, gives employment to about 12,000 men. Across the train yard of this plant has been installed a very important safety device, a viaduct 422 ft. long, which we believe saves many lives and limbs annually. Sometimes there is a railroad track between a roadway and a mill; and in that case, where practicable, a viaduct is provided. The roadways throughout the plant are macadamized, and, being well defined, have a tendency to keep the men from taking dangerous short cuts over tracks.

At all of the entrances to the plants of the National Tube Company illuminated signs are displayed, upon which are shown safety precepts. These sermonettes, which con-



Hinged Plates at Side of Roller Tables



Curved Plates Over Sprockets, Chains, Shafting, Etc.

tinually remind the men that, to a large extent, they are their brother's keeper, are painted on glass slides in English and foreign languages and are changed periodically. We have also copied from the National Tube Company the idea of calling to the attention of men asking for employment the stress that is laid upon the prevention of accidents. This is a sign at the employment bureau stating that if men are not willing to be careful of their own and others' safety we do not want them in our employ.

At the docks of the South Chicago plant, 3,826,000 tons of iron ore were handled during the season of 1910, and there were no accidents causing the loss of more than two weeks' time to any man. There were four men injured during the year who lost less than two weeks' time each. At the docks where iron ore is taken from vessels by machinery all of the unloaders have been thoroughly equipped with ladders, stairs and railed walks, and all gears and shafting have been guarded. At different points along the main roadways of the plants are signs regarding the prevention of accidents and reminding the men of the necessity of being familiar with the safety rules.

All trestles from which material is handled are equipped with walks. All walks are railed and at the base of the railing is a guard board to prevent material or tools falling on a person passing below. Where there is a driveway or passageway under the trestle it is completely planked over at that point between the rails and between the tracks. Where there are several tracks on these trestles, a walk is provided down the center of the trestle for the use of switchmen and men dumping the cars. Under these trestles are pockets in which the material is stored. The gears operating the drums forming the bottom of these pockets are covered, and a rope safety line is stretched the entire length of the pockets, which, if pulled, cuts off all power, sets a brake and stops all machinery.

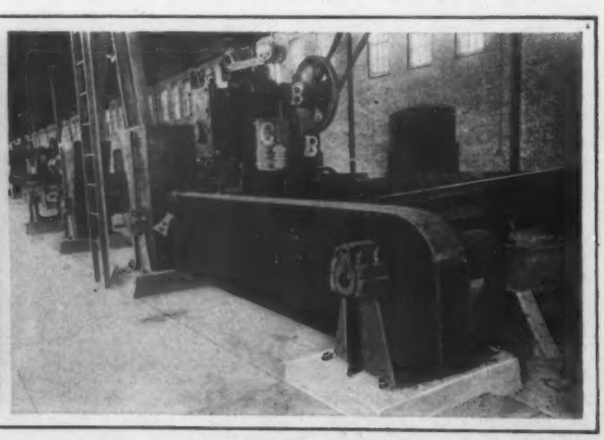
Safeguards for Blast Furnace Department

The new, thin-shelled, water-cooled blast furnace is equipped with a system of stairs and platforms to facilitate safe inspection of the furnace and water-cooling apparatus. At blast-furnace plants all stoves and furnaces are connected by walks provided with hand railings and guard plates at the base of the railings. Each cast house is equipped with stairs or runways leading away from the furnace so that in case of a break-out the men can quickly leave the danger zone. All elevated floors are railed; the cast houses are roofed with steel plate to protect the men from material blown out of the top of a furnace; and the side sheeting on the cast houses is brought down so far that storms cannot beat in on the runners. One of the main precautions to be taken in handling hot metal is to keep all utensils dry.

Where ladles are loaded under the floor of a cast house the casting holes are guarded by grates. The whistles in the blowing engine room are operated by a switch placed behind a shield together with the furnace-pressure gauge and the snort-valve lever. When the switch is thrown in—to blow the whistle—it lights an electric lamp placed above the switch, which shows that the circuit is complete. It also lights a lamp in the blowing engine room, showing which furnace is signalling. The shield is for the purpose of protecting the man giving the signal or operating the lever to reduce the pressure should something go wrong with the furnace. All bustle pipes on furnaces are equipped with railed walks. Men are not allowed to go on the bustle pipes or anywhere above the furnace floor without permission from the foreman in charge of the furnace. He stations another man to watch this man while he is above to guard against the dangers from gas. The mud gun, which is used in stopping the tapping hole of the furnace, is equipped with a funnel-shapped casting to prevent the men attempting to kick the mud, which collects on the cylinder, into the hole, thereby endangering the catching of their feet by the plunger. Since the installation of these guards some four years ago no accidents have been caused in this way. Prior thereto a workman lost half of one of his feet.

It is sometimes necessary to work where there are large quantities of gas and the men are provided with safety helmets to be used in doing this work or in doing rescue work. Each blast-furnace plant, and each gas-engine plant is equipped with these helmets, and a care-

Steel Shields for Guarding Bar Mill Wabblers



Protection of Drive, Rail Mill Finishing Department

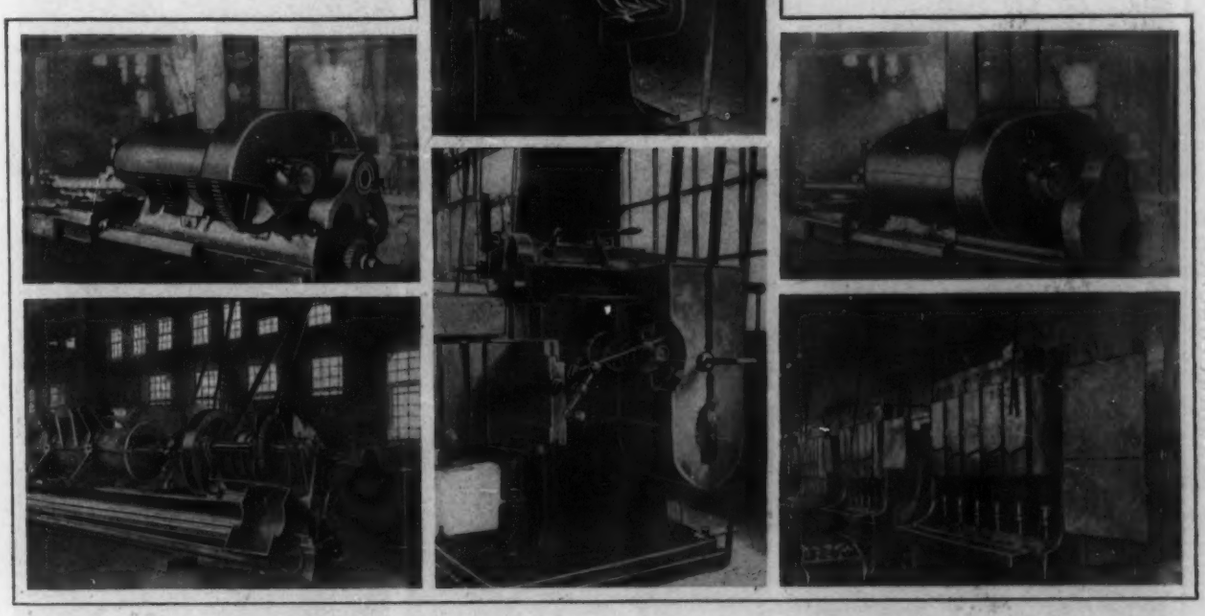
fully trained corps of men is always on hand. On all large gas pipes used in blast-furnace plants, or at gas producers, the tops of the pipes are provided with hand lines to keep men from falling off. The weights on the explosion doors on these pipes are provided with safety chains, so that should the hinge supporting the door break the weight or door cannot fall on men passing below. On the gas-washing apparatus has been installed a system of platforms and stairs. At the base of the stairs there is a railing to prevent a person descending the stairs suddenly stepping on the railroad tracks which pass close by these washers. By causing him to walk around the end of the railing his attention is called to the danger from an approaching train.

In the open-hearth plants on the side of the building on a level with the overhead electric-crane track are built platforms for use in crane repairs. There are three of these platforms along this floor. This does away with the necessity of using swinging scaffolds in repair work.

In order to prevent the stoppers of ladles dropping from the hook as they are lifted from the pouring ladles a special hook has been devised. The point of this hook has been elongated and curled so that the stopper is securely held. When ladles of metal are hoisted by cranes to be poured into mixers it has been customary to attach the hook of the auxiliary hoist (which is used to tip the ladle when pouring) while the ladle is on the ground. There is danger of the auxiliary hoist being raised faster than the main hoist and pouring the ladle while in mid air. To overcome this a hook has been devised which the crane operator attaches after the ladle has been raised to the pouring position.

On the pit side of the open hearths, where the steel is poured into molds and immediately back of the cage of the cranes handling the molten metal, there is an escape platform for the craneman, to be used if there is an explosion of hot metal. This platform extends through the side of the building and is provided with railings and stairs giving the craneman a quick means of egress from the danger zone. In rebuilding an open-hearth furnace the furnace and ports are torn down a number of feet below the charging floor, and in order to prevent material being knocked down on the workmen a plank fence is built at the top of the opening. Prior to the installation of this precaution it was not uncommon for a workman to sustain injuries from this source—one poor fellow sustaining a broken back.

The doors at the bottom of the cupolas are usually held shut by a steel prop, and in order to drop the cupola when cleaning out refuse these props are knocked out with a long bar. The dropping of the doors is accompanied by sheets of flame, and in order to protect the men steel guards have been placed with holes through which the bar used in knocking out the props is inserted. Prior to the installation of these guards a man working on the night shift had lain down back of these cupolas and was not seen by the men dumping them. He was so seriously burned by the flames that he died. When the cupolas are relined there is danger of loose brick falling from the stack on the men. To prevent this a screen is put in at the top of the cupola, so that should a loose brick fall the screen will catch it. The tops of dolomite cupolas frequently are covered only by the I-beams upon which the tub rests when it is dumped. It is important that cast gratings, which entirely cover the top of the cupola, except where the tub is dumped, be installed, making it impossible for a man to slip and fall into the cupola. It is also essential that the platform at the top of these cupolas, which is about 30 ft. above the ground, be equipped with a railing and a high guard at the base of the railing to prevent material being knocked off on men below.



Partial Cover to Lathe Gears
Two Part Hinged Gear Cover

Two Views of Belt Shifting Device
Reached Outside of the Guard

Complete Cover to Lathe Gears
Guards on Nut Tapping Machine

Protection Provisions for the Rolling Mill

In the electrically operated mill motor-room guards are placed over the driving shafts. These guards are so constructed that they can be lifted off. In the rolling mills guards are placed over all shafting and gears. Where the tables are low the guards are so constructed that they cover the table shafting and the sprocket wheels and the shafting on the floor, at the same time giving easy access to the top of the tables. The sides of the roller tables are guarded by hinged plates. Subways or viaducts are provided where passageway across a mill is required. This does away with the temptation of climbing over the tables instead of going around, thereby endangering the workmen being struck by the hot steel moving on the tables. The subways are roofed with plate to prevent hot scale from the steel falling into them and all shafting passing through the subway is enclosed.

Guards cover the gears and flywheel of the bloom shears in a rail mill. These gears are entirely encased and little doors are provided in the guards for inspecting and oiling. To protect a workman standing back of a mill roll, while operating a table, from scale, which flies from the steel as it passes through the rolls, glass shields

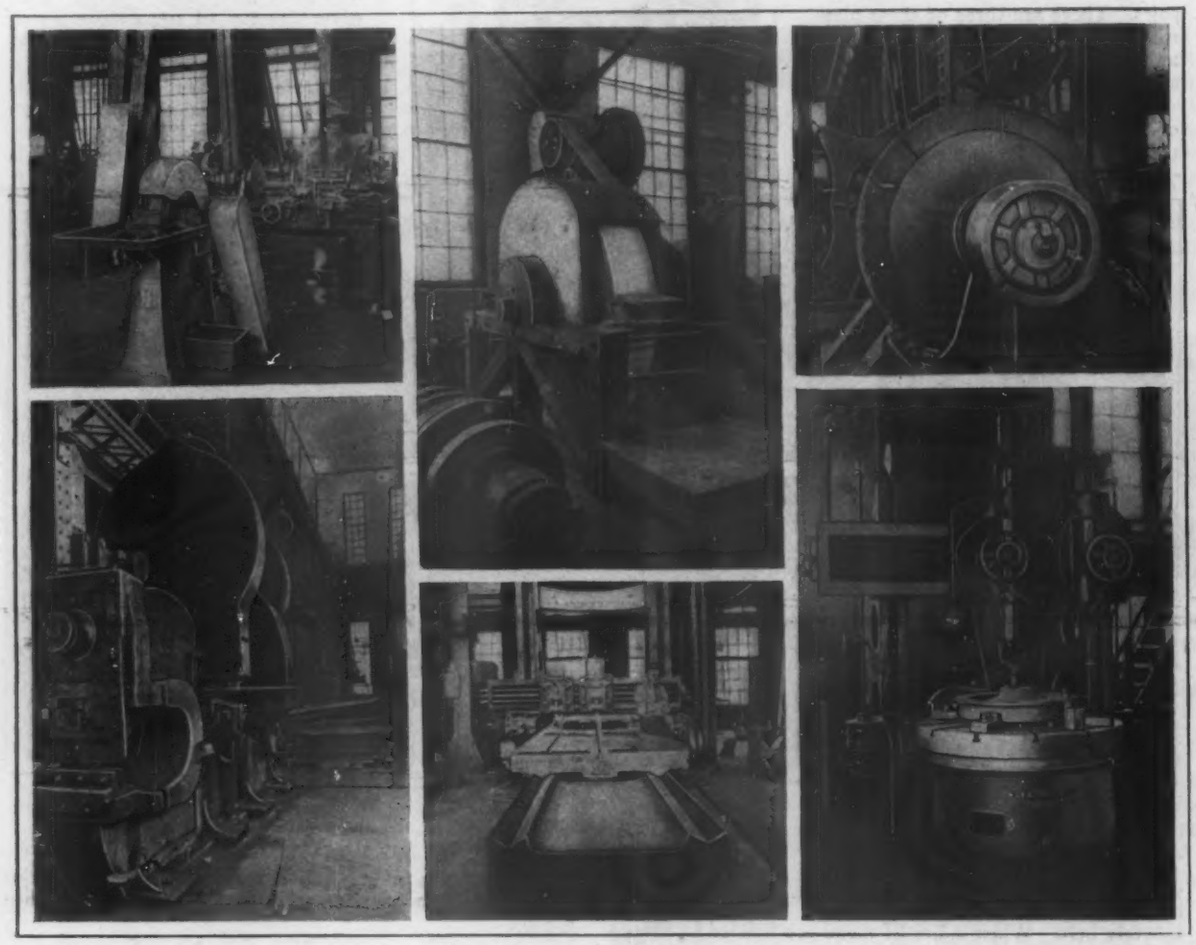
are installed through which he looks as he operates the levers.

A series of guards for different parts of machinery is shown at the cambering machine. First, is a guard over the coupling of a motor shaft; then a steel guard encasing the gears; a plate guard enclosing the spindle or shaft and a plate guard over the coupling boxes which are, in reality, two shafts. These guards are so constructed that they may be lifted off.

One of the most important rules that we have is that all levers controlling the operation of machinery shall be so constructed that they may be locked when on center, making it impossible for the power to be turned on accidentally. Workmen are required to attach a warning tag to this lever lock before working on the machinery. This style of lock requires the use of both hands as the lever cannot be moved without depressing the spring and turning the locking device down.

falling off and striking a man walking on the track below. This was brought home very forcibly by the death of a foreman who had been in our employ over 20 years.

At sheet mills chain conveyors frequently are used to carry the plates from one table to another. A semi-circular plate shield is used in a situation of this kind to guard the sprockets and chains, as well as the table shafting and gears. All belts and pulleys are guarded to a height of at least 5 ft. The apparatus shown here drives the live rollers in the finishing department of a rail mill. An economical and simple way of guarding shafting is by using a guard consisting of a steel plate bent into a triangle or inverted U and attached to the bearings and gear guards. In sheet mills, where the plates are partially straightened by pressure applied by means of worm gears, cast guards are placed over the works. A railed platform is installed on a roll housing to provide for the safety of the man working on top of the rolls.



Protection for the Emery Wheel Covering Gears and Flywheel of Shear

Method of Protecting Large Grindstone Plate Guard Over Bed of Planer

Broken 26-in. Wheel Held Together Guards for a Boring Mill

At machinists' headquarters and at points where operators congregate are displayed large enameled steel signs bearing the wording, "Never work on a table, crane or other machinery before notifying the operator and attaching a danger tag, bearing your name, at the point where the power is turned on. Get these tags from your foreman." The workman's name is either painted or written on the tag.

A protection is placed over the roll-train spindles or driving shafts of bar mills. These shafts are about 3 ft. from the floor and the guards are on legs making them light and convenient for handling. The ends of the wabblers on these roll trains are guarded with steel shields. It has been said that these wabblers—which are, in fact, the ends of the roll necks—are not dangerous, but one instance has come to my attention where a workman's clothing was caught on one and he was killed.

At the ends of all loading beds are placed guards which will prevent material falling off, but which can be lowered when the material is loaded in cars. The material is stacked on the beds and there is a possibility of a piece

Among the views may be seen the guards used on nut-tapping machines and on bolt threaders.

In blooming mills a mask is provided for the man working at the rolls to protect him from sparks and scale which fly from the steel being rolled.

In the plants of the American Steel & Wire Company automatic stops are provided at the wire-drawing blocks. The rod or wire which is being drawn is carried through the eye of the lever connected with the motive power so that a snarl in the wire will throw this lever forward and stop the block. In addition to this safety device a rope is attached to the lever, carried over the sheaves above the frame, and down at the right-hand side of the block, so that if a man should be caught and drawn around the block he would strike this rope and stop the block automatically.

Guards in the Machine Shop

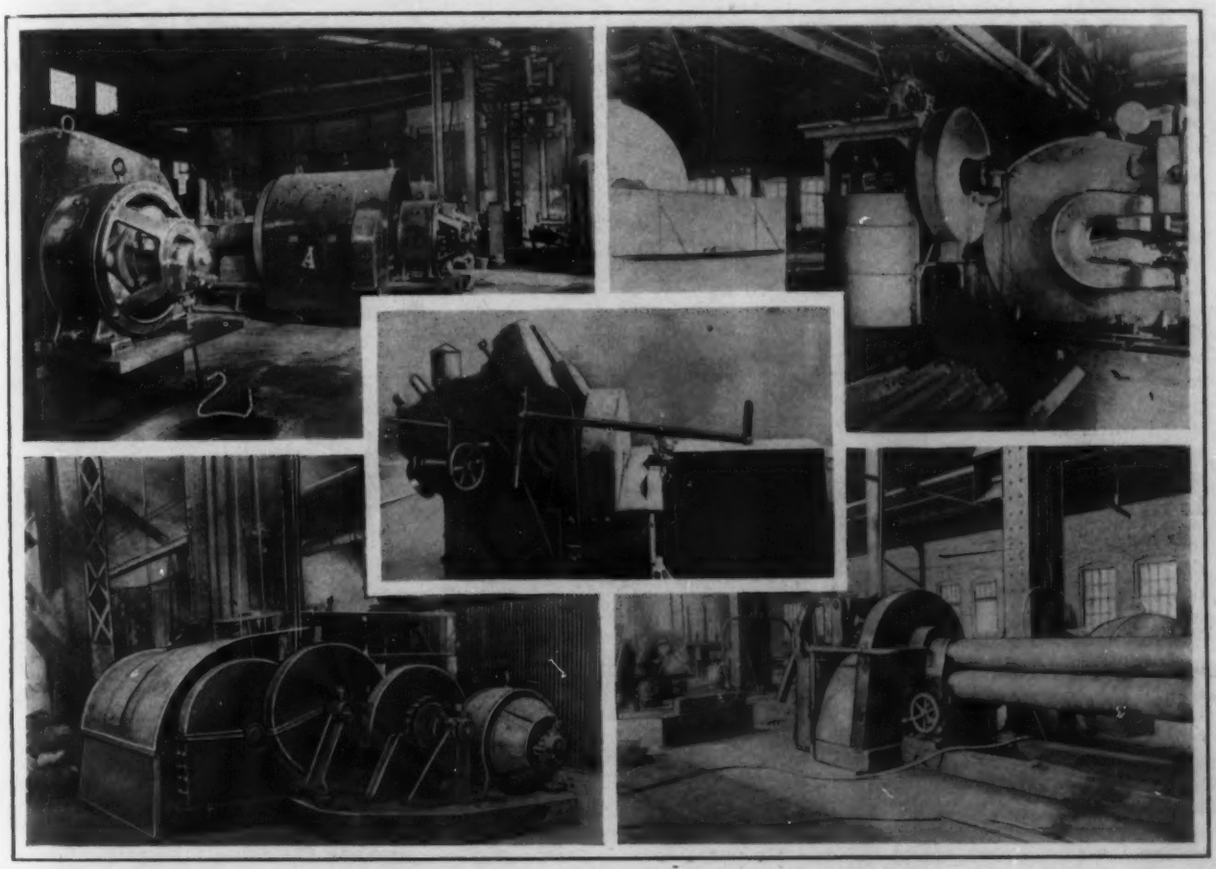
We feel that it is necessary to encase gears of lathes entirely, as the danger of being caught between the end of the guard and the cog of a gear, where only partial cov-

ering is used, is almost as great as being caught in the gears themselves. It is necessary that the feed gears of a lathe be so guarded that the shield may be easily removed for changing the speed, etc. All of these shields are so constructed that they can be swung back out of the way.

In order to guard the belt on a cone pulley it was found necessary to devise a shifter which could be worked through the guard. Mr. Kilts, a member of one of our mechanical safety committees, has invented such a shifting device. It is not only a perfect safety device, but it has been found that it increases the speed of operation. This shifter is so constructed that it is impossible to run the belt off the end of the cone.

There is danger of having a limb caught and sheared off between the table and ribs of a planer bed. A plate guard placed over the bed eliminates this danger. When the top and bottom gears, install a plate guard in front of the mill table and place a guard around the counterweight, so that should the cable supporting the weight break the weight cannot fall on any one.

We require that all emery wheels over 8 in. in diameter shall have a safety taper of ¾ in. to the foot and be provided with safety collars. This means that the wheel will be convex in shape, while the collars will be concave, and should the wheel break (split), it being thicker at the hub than at the face, the pieces are held in place. In the American Steel & Wire Company shop small die grinders are equipped with heads, plate-glass shields to protect the workmen's eyes, exhaust systems and shaded electric lamps. This is a model installation. An actual demonstration of the efficiency of this style of wheel was given when a 26-in. wheel, running 6000 ft. rim speed, split



Complete Covering of Roll Shop Lathe
Guard Over Gears of a Bevel Shear
Standard Method of Covering Gears
Gear Covers for a Vertical Punch
Covering Gears of a Bending Machine

the beds are left open they are used frequently as a receptacle for tools, oil cans, etc. It is only a short time ago that I noted a newspaper report of an accident where a workman slipped and his head was caught between the table and frame, killing him. Recently a workman had his fingers injured while trying to get oil out of an oil well in a planer, to cut the grease on his hands. To prevent a similar accident we have placed plate shields over these oil wells. It has not been customary to place guards over the feed gears of a planer. Investigation showed, however, that men have lost the ends of fingers in these gears by attempting to adjust them while keeping their eye on the job on the planer. Such guards, therefore, have been installed on all planers. The workmen at first objected to these guards as they thought they were unnecessary and a nuisance. They have been in use for some time now and the men raise no further objection to them and are, in fact, becoming as enthusiastic as the mechanical safety committee in devising new ways to prevent accidents.

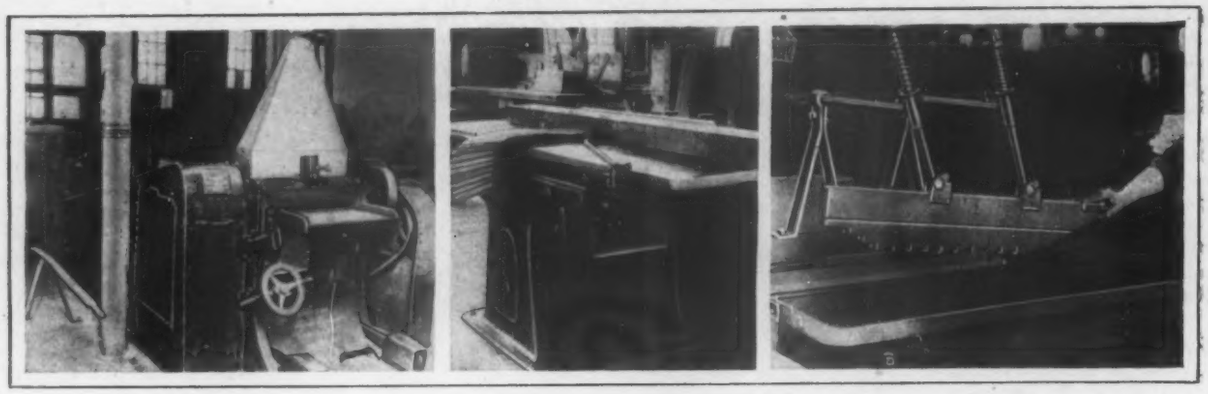
In some work, such as facing the under side of a cut, it is not practicable to use the patent or smooth chuck, but the use of a set screw is necessary. When this is the case the set screw is countersunk and guarded by a sliding cover. The method of guarding a boring mill is to encase into several pieces, all of which were held by the safety collars.

It is necessary that large grindstones be provided with substantial guards over the stone. It was only a short time ago that I received a newspaper clipping of a fatal accident caused by a grinder of this kind breaking. An accompanying view shows a guard over a nest of gears driving a bevel shear. Another, a method of guarding the gears of a bending machine. Another shows the guards over a double-shear flywheel and gears. The guards over a vertical punch are shown in another of the illustrations.

In the roll shop all gears on the lathes are so guarded that it is impossible to come in contact with them. The standard requirement for gear guards is that the gears shall be covered on the sides as well as on the face, and that the guards shall cover the gears to such an extent that the danger of being caught between the end of the guard and a cog of the wheel will be eliminated.

Safety Devices for Pattern Shop and Foundry

Band saws have a hinged guard covering the top and front of the saw to prevent the saw flying should it break, and a head guard extending down the front of the saw to prevent the workman's head accidentally coming



Belt and Pulley Covers in Carpenter Shop

Safety Cylinder for a Wood Joiner

Saw Guard Handling End of Piece

into contact with the saw. The saw below the table is encased. There has been a great deal of difficulty in finding circular-saw guards that were practicable where many thicknesses of wood were sawed. Mr. Roberts, a member of one of our mechanical safety committees, has invented a guard which the workmen say is all right. It may be because their foreman devised the guard. A different style of circular-saw guard has been devised by Mr. Walker, a foreman of the Tennessee Coal, Iron & Railroad Company. It consists of a hinged arm extending over and covering the saw, and supported by a wheel resting on the saw table. The size of the wheel depends on the thickness of the wood sawed. For instance, a saw cutting up to 3-in. material would have a guard wheel of from 7 to 8 in. in diameter. Mr. Offutt, of the National Tube Company, has devised a guard which, in addition to guarding the saw, is used to shove the last end of the piece through the saw, and which is a very important provision.

We feel that the belts and pulleys in the carpenter shop should be so guarded that there will be no danger of timber being caught in them. They are entirely enclosed in steel casings. It is important that the knives of a wood joiner be guarded. We have used a guard over these knives for a number of years, which we have found to be satisfactory since it has been equipped with a strong spring to draw the guard back. However, one of the best safety devices for these machines is a safety cylinder, which, instead of pulling the man's hand into the knives, throws it out of the machine, and instead of losing his fingers or hand he sustains comparatively slight cuts. We had an actual demonstration of the efficiency of this style of cylinder recently. The workman was planing a short piece when it slipped and his hand went into the machine. Instead of being seriously hurt he received only a slight cut, and after having it dressed returned to work. A wood joiner so equipped is here shown.

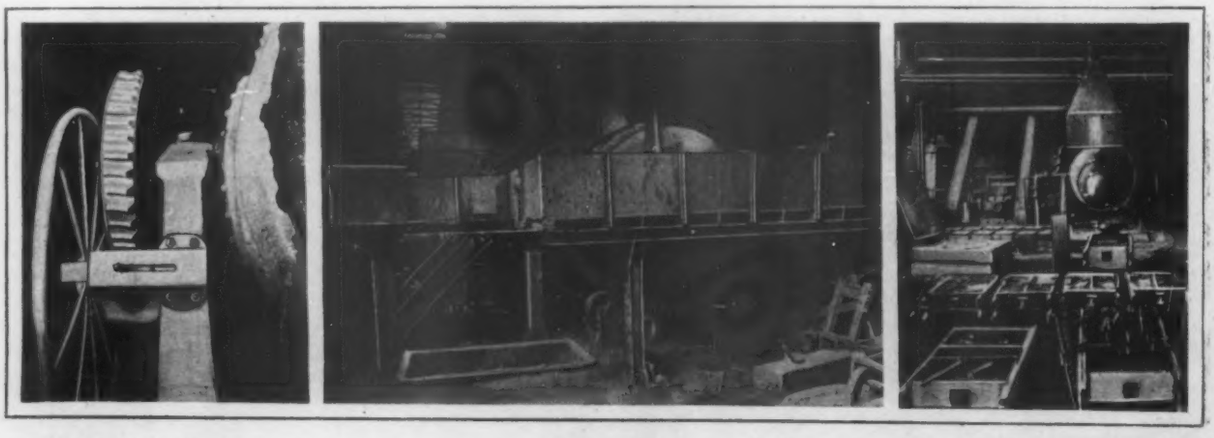
Example of Protection Afforded by Use of Goggles—Babbitt Metal Covered One Eye Which Probably Saved Both Eyes of Employee, Who Received Merely a Slight Burn About the Face

Men working on high elevations, such as on smokestacks, have usually placed their dependence on one set of tackle. It is now a rule that these men shall wear safety belts and life lines, which are attached independently of the other tackle, so that should the tackle holding the scaffold break the man will be supported by his life line. This is another proposition which the men did not take to kindly at first, but which they would not now work without.

It is compulsory that men ragging rolls wear masks to protect their eyes and face. In the chipping yards each man is given a pair of goggles free of charge and urged to wear them. Every morning the foreman makes sure that each man has a perfect pair of goggles, and calls his attention to the necessity of wearing them. Most of the men do wear them—on their hats. Another instance of a safety device that prevented an accident. A man was pouring babbitt when it exploded. Had he not been wearing the eye shields he would have lost the sight of both eyes.

In the foundry the large receptacle or mixer in which iron is retained before it is poured is provided with a plate fence, instead of railings around the platform to prevent the crane hooks from catching. The levers controlling the operation of the mixer are guarded with plate shields for the same purpose. The brass converter of the foundry is provided with a spark shield. I would call attention to the necessity of a locking device being attached to the wheel used in tipping this converter, as when heavy with skull it will tip over if not locked. We have had an actual demonstration of this.

A large percentage of accidents occur in a foundry from feet being burned by slopping metal. It is very important that the workmen wear whole shoes and that they



Locking Device for Converter Tipping Wheel

Plate Fence Around Foundry Mixer So Crane Hooks Have Nothing to Catch On

Plate Shield for the Foundry Brass Converter

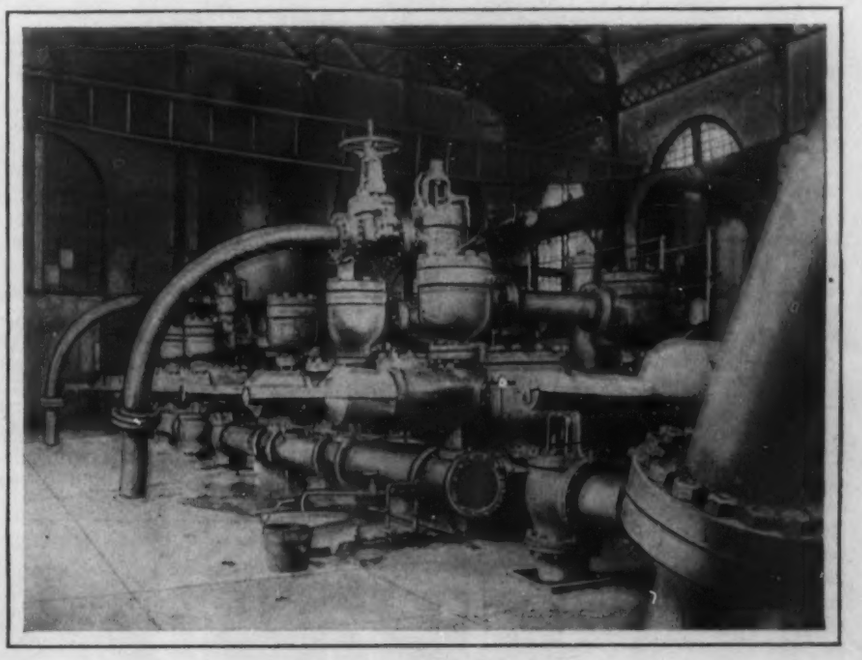
be so constructed that they may be slipped off quickly. We urge upon the workmen the advisability of wearing the so-called Congress shoes. Many accidents are prevented by placing a guard on the foundry hand ladles. This consists of a steel shield on the side of the ladle over the handle. If the workman stumbles and slops the metal the shield protects his hand.

Precautions for the Power Plant

The ends of piston rods extending beyond the cylinder heads should be guarded, the purpose of the shields being to prevent a man getting so close to the cylinder that he will be struck by the rod.

In the boiler house a railed walk is placed on each boiler and leads from boiler to boiler. The water gauge glasses should be guarded. A guard devised by the American Steel & Wire Company is a semi-circular shield so constructed that it may be turned around, coming between the workman and the glass, while the glass is being tested or heated. It is then turned back of the glass, giving an unobstructed view of the gauge. To assist in seeing the water line there is an electric lamp installed at each water gauge. Each boiler is equipped with a non-return valve so that if a tube bursts, or there is some other explosion, the valve closes automatically and the steam cannot rush into this boiler from the other boilers. All relief valves are piped through the roof so that steam will not blow off in the building. There are a number of precautions set forth in our boiler-house rules, such as numbering boilers, blow-off-line relief, stop valves, valves in feed-water connections, drains in pockets, etc.

All flywheels are guarded, either with plate or wire-net guards. Where the protection is within 18 in. of the wheel it is 5 ft. high, and where it is more than 18 in. from the wheel it is 3 ft. 6 in. high, which is the standard hight of all railings. The guard is carried over the bearings of the wheel at the same relative hight. At all points on engine beds where the oiler may have occasion to walk, railings or plate guards are provided. The governor balls are guarded. The governor is driven by a three-rope drive, dependence not being placed on a single rope or belt. A device has been installed which will show when a strand in a rope of a rope drive is broken. The broken strand strikes a board hinged to the pulley guard, throwing the board back and attracting the attention of the engineer.



Shields for Ends of Piston Rods

Accident Prevention on Cranes and in Railroad Yards

The statement has been made that 50 per cent. of electrical accidents are chargeable to the overhead electric crane. This is not borne out by our records. However, our guarding of these cranes and our operating rules are quite elaborate. All overhead cranes are provided with railed walks on both bridge girders, extending the entire length of the crane. The trolley or carriage is entirely floored and provided with a railed walk. Each hoist is equipped with an over-hoist limit switch, which prevents running the blocks into the drum, probably breaking the cable and dropping the load on the workmen.

Each crane has a safety switch, installed on the bridge, which will cut off all power, making it impossible for an absent-minded operator to forget that men are working above and start the machinery from the cab. When a man goes on top of a crane he pulls out this switch and puts his "Danger—Do Not Move" sign on it. A box is provided on the crane bridge in which to keep oil cans, tools, etc. Each crane is equipped with guards extending out from the truck wheels, the purpose being to warn a person resting his hand on the rail of the approach of the crane, which he might fail to note because of other noises. The number of arms and hands lost by persons working on scaffolds along crane runways thoughtlessly resting against the runway and failing to notice the approach of the crane is appalling. Four instances have come to my attention during the past year where these wheel guards have prevented such accidents. All trolley gears and the truck drive gears are guarded. The flooring over the trolley carriage is important, both from a safety standpoint and from an operating point of view. It prevents the falling below of pieces of machinery and makes a good repair platform. Where ladders have to be used in getting to and from cranes a landing platform is provided at the top of the ladder, with a short ladder leading from the platform to the cage. This prevents a man climbing the main ladder so high that he can take hold of the power rails. Where possible, stairs are provided. Where practicable, steel walks, with proper railings and toeboards at the base of the railings, are placed parallel with all crane runways. This is not only an important safety precaution, but is of great assistance in operation. All gantry cranes are equipped with fenders over the truck wheels, a walk the entire length of the crane bridge, and a safety switch on top of the bridge; and with automatic warning bells.

All switchboards carrying a voltage of over 250 volts are encased, making it impossible to accidentally come in contact with the live parts. The guard on the front of the board is semi-circular, with the handle projecting through it. The fuse blocks are covered with an asbestos-lined steel box. The back of the board is covered with a plate and all guards are grounded to the board, which in turn is grounded. Each board of this type is equipped with disconnectors, making it possible for the board to be rendered "dead" when it is necessary to work on it.

The danger of being caught between a locomotive crane boiler and the truck frame as the crane boom is swung back and forth may seem remote, but reports show that such accidents do occur. A device has been installed on the truck frame consisting of a fence which guards the danger zone while the crane is working, but can be folded against the frame when the crane is running through the yard.

Where a railroad track runs close to a building railings are placed at the corners of the building to prevent men suddenly stepping from the building on the tracks. Where there is a narrow space between the building and the track in which a man might attempt to stand as a car is moving by, and be crushed by the cars, and it is impossible to get a safe clearance by throwing the track over, an inclined plate is placed over this space, making it impossible for a man to get in this dangerous position.

In the guarding of valve pits and trap doors the Barnhart cover is so devised that three sides of the hole are

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Mechanical and Civil Engineers,
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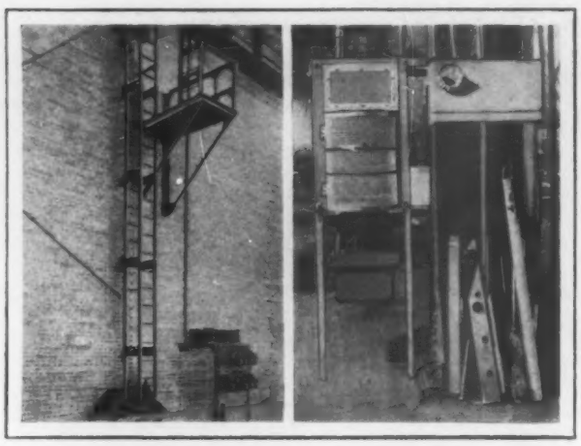


Landing Platform for Reaching Crane — Method of Guarding Local Switchboards

guarded when the cover is up. The rods drop down out of the way when the cover is closed.

When men are working on or about cars the necessity of placing a danger signal to protect them is obvious. A warning sign, or track flag, devised by the National Tube Company, is so constructed that it cannot be blown down, being clamped to the rail; nor can it be knocked down by a car, and the claim made that it was not in place as the resulting wreck of the sign will show that it was in position. Cleanliness about the shop and yards cannot be too strongly urged, as there is no question as to its being a factor in causing the men to be more cleanly about their work and in preventing accidents due to cluttered-up or untidy conditions.

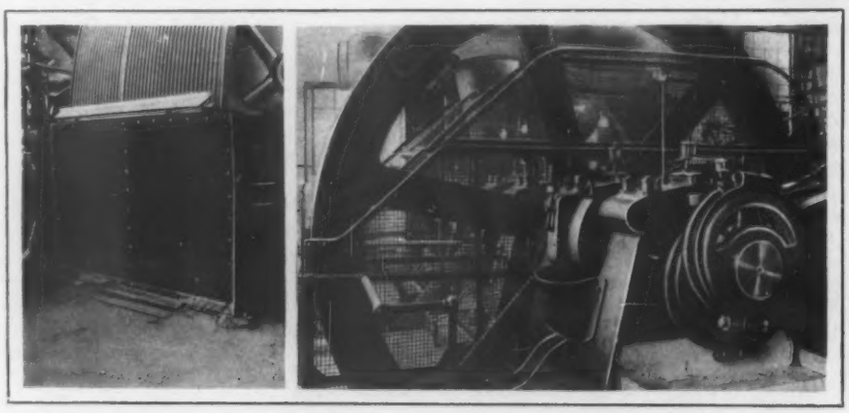
The Promulgation of Rules for Safe Operation

The Central Committee of Safety of the Illinois Steel Company is engaged in standardizing safety measures and devices. After careful consideration it adopts and recommends for use at all plants of the company such devices as seem to be most efficient and likely best to prevent accidents. A book of plans for devices for safety has been prepared under the direction of this committee for the purpose of standardizing the safety appliances and precautions necessary to protect employees from the dangers incident to machinery and unsafe working conditions and to secure the provision of efficient safeguards and proper working conditions at the time construction work is planned and machinery is installed, as well as to show the conditions to be maintained during operation. This book has been prepared in loose leaf form so that additions or amendments may be readily made to it. The plates in this book are reduced drawings of actual construction, and are intended to be used by the engineering department as examples only. The dimensions shown are not required to be followed unless they are made obligatory in the text of the specifications which appear upon the page opposite to each plate. The descriptive matter is taken from the Construction Rule Book, which will be mentioned later, and incorporates all of the requirements (in an abbreviated form) appearing in that book.

On all plans or specifications for new construction or work by way of replacement it must be shown that a check has been made for safety, and it has been made the duty of superintendents of plants to see that safety devices and precautions provided for in our book of standard safety devices are complied with before machinery or plants are put into operation, and that they are thereafter maintained. No new machinery or new plant may be put into operation unless it has been first approved for safety by the safety inspector, except upon the specific order of the general superintendent or assistant general superintendent of the plant. No machine tools may be ordered unless it has been shown that the plans and specifications therefor have been checked for safety.

This committee has also prepared with great care a book of rules respecting safety in operation. This book is gotten out in two forms. The first for the use of superintendents and foremen, printed in the English language, includes general instructions from the president of the company, regulations respecting cooperation of workmen, rules governing the construction and installation of machinery and the physical conditions to be maintained (which cover the same subjects as those mentioned before as being covered by the book of Standard Safety Devices), and operation rules for the safety of employees. The second, for the use of employees, printed in the several languages spoken by the employees, is distributed to all employees of the company who are not superintendents or foremen, and contains the same matter as the other form, except that the rules governing the construction and installation of machinery, etc., are omitted.

These rule books, as stated, are placed in the hands of all employees of the company, and each employee is required to read the same and to satisfy his foreman that he has read it and is familiar with its contents, and both the foreman and employee are also required to sign a statement to that effect upon a form provided for that purpose. All men when placed at work upon new jobs entailing any hazard at all must be fully instructed by the foreman in charge as to all dangers incident to the work, and when the foreman is satisfied that such workman understands and is aware of all such dangers he is required to so certify to the department superintendent upon a form provided for that purpose, upon which form the workman also states that he has been instructed, knows the dangers and will be careful of his own and others' safety. The signing of such statements practically insures against perfunctoriness in these details. The Safety Committee has also prepared and had printed rules governing the use of high explosives, copies of which rules are placed in the hands of all persons having anything whatever to do with the handling of dynamite or other high explosives.



Telltale of Broken Strand of Rope Drive; Wire Net Guard for Flywheel

The Inculcation of Habits of Caution

Contemporaneously with the organization of the United States Steel Corporation Safety Committee and to the end that the greatest benefit from individual experience might be obtained, a central committee of safety was some three years ago organized. This committee consists of the safety inspector and assistant general superintendent of each of its plants, together with the general attorney, who acts as chairman of the committee, his assistant in charge of accident matters in the law department, manager safety and relief department, who acts as secretary of the committee, and a stenographer, who takes a record of all the proceedings of the committee. This committee meets at the main office of the company at Chicago once every month for an all-day meeting. At these meetings all accidents occurring at the several plants of the company which are in any wise serious in their results are discussed and ways and means devised for the prevention of the

occurrence of similar accidents at the same or other works wherever this is possible. General conditions are likewise examined into and, if in the observation of any of the members of the committee, any safety precautions or devices seem to be desirable or necessary, the committee considers them and makes appropriate recommendations. The recommendations of this committee are accepted and put into force at all plants without question unless some special circumstances make it impossible to do so.

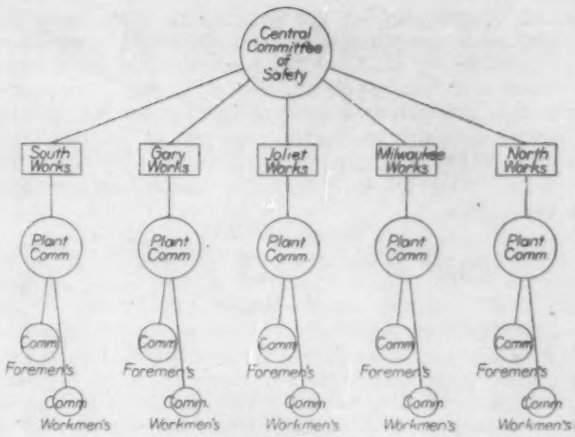
In considering the questions that come before this committee it does not depend solely upon the judgment of its members, but it is the practice of the committee to obtain the advice and judgment of the men of its several works who are specialists upon the particular branch of the work that may be involved in the question under consideration. All matters that are considered, except possibly some minor ones, are first made the subject of discussion and consideration at meetings of the department superintendents at the several plants, and are gone into by the members of the committee at each plant very carefully and thoroughly with the heads of the departments in which the particular situation may exist, and are also gone into, where possible and advisable, with special committees, such as of blast furnace superintendents or chief electrical engineers, etc., and the permanent and workmen's committees, which will be mentioned later. All of this is done for the purpose of obtaining the very best judgment that is available in the consideration of the more important questions that come before the committee and to the end that when any action is taken and a recommendation made by the committee it may be sure that the best results will be obtained. This procedure of conferring with the department heads and others at the several plants also aids much in facilitating the early installation of any device that may be decided upon, as the same are more often than not the result of the thought of the men themselves.

The statistics of foreign countries (as well as those of the United States) show that the large majority of accidents is due to a lack of care on the part of those injured or on the part of those with whom the injured was working, and I believe we will all agree that the acquiring of habits of caution is the secret to success in this work.

One of the first steps taken by the Central Committee of Safety to interest the men and assist in inculcating habits of caution into their minds was the organization of Safety Committees at all the plants of the Illinois Steel Company. Two plans have been followed in this work, namely, the organization of committees composed of foremen, known as Permanent Safety Committees, and the organization of committees composed entirely of workmen below the grade of foremen, called Workmen's Safety Committees.

Permanent Safety Committees

Each department has a committee of foremen known as the Permanent Safety Committee, because the personnel of the committee does not change. It is the duty of this committee to make monthly inspections of their department as a committee. It is also their duty to see that



Organization of Safety Committees, Illinois Steel Company

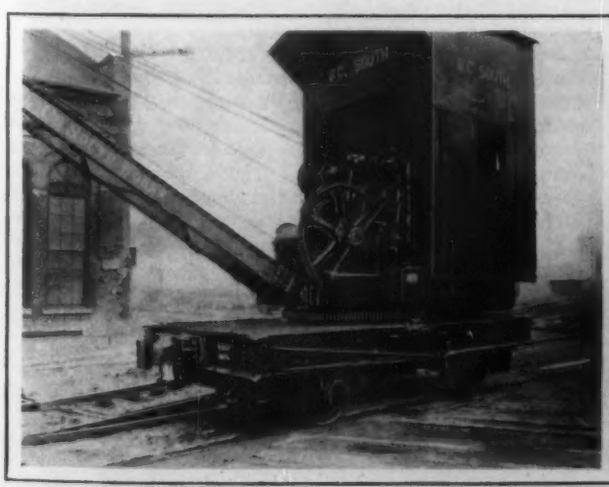
all safety devices approved by their superintendents are installed, and to investigate all accidents where the injured man loses ten days' time or more, or where there is some special feature in the case. In making this investigation they report how the accident occurred, what they think can be done to prevent a similar accident, whether in their opinion any one has been negligent and what they think should be done with the negligent person.

This inquiry into the alleged guilt of an employee by a "jury of his peers" has had a very beneficial effect and has done much toward reducing the number of accidents. Care is taken by the superintendents to see that the investigations made by the committees are not merely perfunctory, and their reports have been very satisfactory. Where the injured man has been careless the committee does not overlook this fact, but lets him understand that it does not approve of his actions.

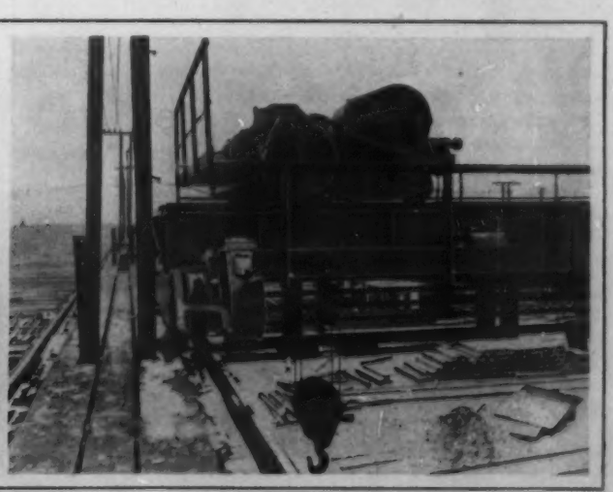
Workmen's Safety Committees

The plants are divided into divisions, each consisting of three departments or mills. One workman is chosen from each department to act as a member of the committee, to inspect for dangerous places, to consult with the men at their work and get suggestions from them as to safety methods of doing that particular work, and, incidentally, to sow seeds of caution. These men serve on the committee one month and spend one day each week inspecting their division.

When a committee is organized all of the superintendents of the departments making up that division meet with the committee and the safety inspector and the nature of the work is gone over with the committee, impressing upon them the interest taken in the work by their superintendents. We believe that this committee work is causing the men to take more of an interest in their own and others' safety. The men are urged not to drop the work after their term on the committee has expired, but to continue to report any change that they think would be beneficial, and it is a pleasure to note that many of the men continue to make suggestions. The superintendents



Folding Fence Extending from Locomotive Crane



Crane Gear Covers and Walk Along Crane Bridge

advise that it also has caused other men who have not served on a committee to come to them with suggestions. In directing the work of the committees we have inter-division and inter-works inspection, having a committee inspect a division or a plant other than its own, thereby creating a rivalry among the men, and at the same time giving the work greater importance in their eyes and making it more of an honor to be selected as a committeeman.

Boosts for Safety

As a further assistance in the inculcation of habits of caution in each department and at each plant entrance are installed safety bulletin boards. Upon these boards are displayed the list of departments successful in keeping in the "Booster Class" during the past month, i. e., the departments that have kept their accidents below a certain percentage. Clipping bureaus supply the plants with newspaper reports of industrial accidents occurring throughout the United States, and these clippings are posted on the boards, together with rules and photographs of devices of the Illinois Steel Company which would have prevented the accident. In addition to this is posted any other matter or photographs which will attract the attention of the men and keep them interested in safety.

Another stimulant to the advertising of safety is the distribution of cigars with the "Boost for Safety" bands. Boxes of these cigars are distributed among the foremen and workmen whenever records are made in keeping down accidents or when suggestions for safety are made or whenever it appears that the giving of cigars will help the cause along.

"Boost for Safety" paperweights are presented to the foremen and workmen, the idea being to keep always before them the fact that the safety of workmen is the first consideration.

The plant managements have caused to be made a badge of distinction which is presented to each man showing a thorough knowledge of the safety rules. The workmen, as well as foremen, compete for these badges. It is, however, compulsory upon the foremen to take an examination on the rules and precautions governing the prevention of accidents. In order to obtain a badge it is necessary that an examination be passed with an average of at least 90 per cent. efficiency. This move is not only insuring a better knowledge of safety rules and precautions on the part of the foremen and workmen, but the eagerness with which all classes of workmen are competing for the buttons and the pride shown by those successful in obtaining them has proved it to be a valuable aid in the inculcation of habits of caution into the minds of the men.

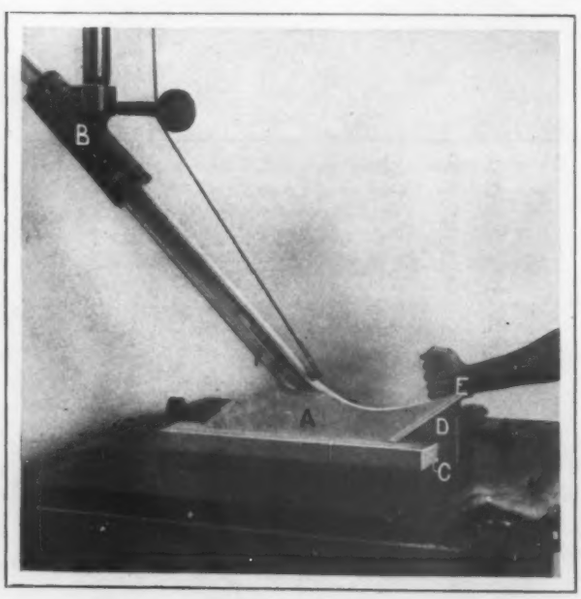
A very natural question, in view of what has been said as to organization and safeguarding work, is—what has been its effect? While satisfactory statistics are not available at all of the plants of the corporation, from which a comprehensive comparison can be made, the effect of the work at the Illinois Steel Company is a fair example of what this character of work will do. From these statistics we find that serious accidents have been reduced since the energetic safety campaign has been instituted by 50 to 66⅔ per cent.

A Circular Saw Guard

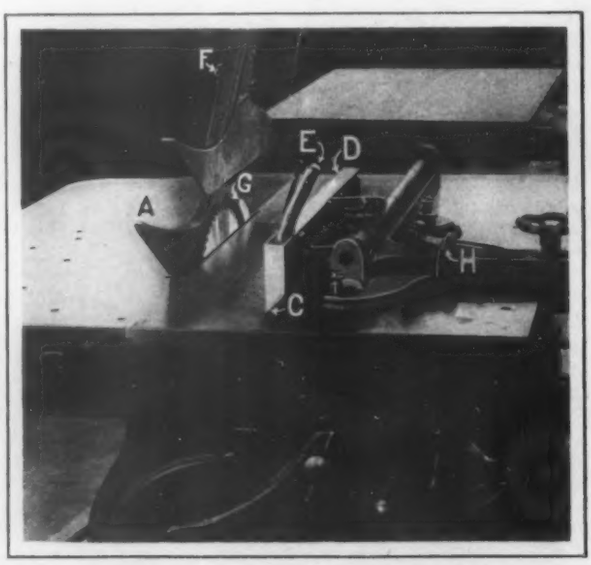
Recent Development at One of the Works of the National Tube Company

Through Thomas Ewing, assistant to the president of the National Tube Company, two photographs of a new circular saw guard recently developed at one of the works of the National Tube Company have been obtained and the accompanying reproductions of the photographs are here shown. They serve well to supplement the article immediately preceding by Robert J. Young, discussing methods of safeguarding employees and illustrating in that connection the Offutt saw guard.

One of the accompanying illustrations shows the guard completely covering the circular saw on both sides and the other shows the right hand side of the guard raised to make a very thin cut. The guard is marked A, in both illustrations. It is counterweighted but maintained heavy so that the guard proper will always remain over the saw. The guard slides up and down at an angle of 45 deg. in the guide B, which is provided with roller bearings. It rises automatically. It is patterned in part after the International Harvester saw guard, and the Worcester saw guard, illustrated in Bulletin No. 2 of the Committee of Safety of the United States Corporation published July, 1911.



Saw Guard Developed at One of the Works of National Tube Company



The Saw Guard with Right Half Raised

A small tongue C is forced out from the face of the fence D by grasping the lever E. The fence is pushed forward by the operator and the piece of wood is carried along with it. By this means a cut on a small piece of wood or a cut with the guide close to the saw can be accomplished with no chance of injury, though both of the operations are dangerous. In the picture showing the right half of the guard raised the fence is very close to the saw for the purpose of making a very thin cut as explained. The right half is adjusted in position by means of the clamp screw F in the slot. A so-called spreader, G, is in line with and of the same thickness as the saw and is intended to prevent a piece of wood from striking the saw teeth and being thrown out with force. The guard A also is a safeguard against an accident of this kind. The sliding fence D is shown in the second view as is also the lever E controlling the tongue C. Ordinarily the fence is held stationary by the latch H, and to slide the fence forward with a piece of wood, the latch is thrown into the position shown in the second photograph.

Improvement in the Quality of American Steel

A Résumé by Manufacturers of the Progress Made in Recent Years, Particularly by Heat Treatment and the Development of Alloy Steels

The criticism was commonly made, in the sharp discussions of three years ago on the quality of the steel furnished the railroads by the rail manufacturers of the United States, that tonnage had been aimed at by the mills at the expense of quality. Foreign critics, in perhaps not an entirely judicial frame of mind, have also had something to say about the American steelmaker's race for tonnage. That our steel manufacturers have given much attention to quality in the past two or three years—much more than might be judged from some of the statements that gain currency at times—is a fact which we believe deserves to be emphasized. To that end *The Iron Age* asked an expression on the question from the various steel companies—those manufacturing the forms of product which are large factors in the country's steel output, as well as those manufacturing tool steels and special steels, whose importance is due to their quality and not to their tonnage. Our letter asked for a discussion of the improvement in quality by the use of ferroalloys, by heat treatment, or by modifications in mill practice that have resulted in steel carrying greater loads, giving greater wear or having greater resistance to corrosion. A request was made for details of the particular direction which work for the improvement of quality had taken in the practice of each company. The replies are a significant commentary on the present movement for the improvement of steel quality. Some of the manufacturers addressed were not prepared to present at this time the results of their efforts. To those who have responded our readers are indebted for an exceedingly interesting symposium.

Improvement of Quality in Steel Wire Manufacture

The same tendency that is typified by the never-ending contest for supremacy between armor plate and projectiles has become of late years characteristic of the steel wire industry. As the possibilities of the material become apparent, there is a ceaseless effort on the part of consumers to adapt it to new uses and make new demands upon it. The effort to improve quality is, therefore, forced upon the manufacturer by every consideration of self-interest, as on the one hand he is desirous of increasing the volume of his output, and on the other hand keen competition compels him to be ever on the alert to maintain his standing.

NEW DRAWN AND COLD ROLLED PRODUCTS

There are now made from drawn wires and their allied product, cold rolled strips, an infinite variety of articles of utility and ornament which formerly were made from different material and by other means, when they were made at all; for the use of the new materials has led to the production of a vast number of articles which otherwise would remain unknown. The effect of this change in the general field of metal working has been greatly to cheapen production and correspondingly to extend use, while at the same time the substitution of the new methods for the old has in most cases resulted in a betterment as well as cheapening of the article because of greater suitability for the purpose, of the material from which it was formed. Among the general classes of articles of this description may be cited the use of cold drawn and rolled steel in place of cast and hot forged iron and steel for nearly everything comprised under the term hardware and domestic utensils; the production cold of an immense variety of difficult shapes in screws, bolts, rivets, chain, etc.; and the development of qualities of steel capable of being worked in modern high speed automatic machines for parts of automobiles, bicycles, sewing machines, typewriters, etc.

CHANGES IN PROCESSES

Concurrently with this enlargement of the field of cold rolled and drawn steel and increase in the severity of the requirements it is called upon to meet, there has been taking place in the United States a radical change in the process of steel manufacture. For reasons having nothing directly to do with the quality of the finished product the basic open hearth is rapidly superseding the Bessemer process. The basic process in particular was introduced primarily because it permitted the utilization of grades of raw material, both in the form of pig iron and scrap, which could not be converted into steel of good quality by any other process. The almost incredibly rapid growth in the total demand for steel has brought the date of the exhaustion of the supply of ore available for the conduct of the Bessemer process within a comparatively few years if the production of Bessemer steel were to be continued at the present rate, to say nothing of the rate which would now exist if the increase in total production which has occurred in the last few years had been made entirely with the Bessemer process. Consequently the output of basic open hearth steel has increased both absolutely and relatively, and ~~so far~~ as we are able to foresee this tendency must continue. The open hearth process has certain points of superiority over the Bessemer process. It is under better control from a metallurgical standpoint, and it is possible to obtain by its means steel of almost any specified chemical composition within very close limits of variation. On the other hand this process is inherently more costly than the Bessemer process, both in charges for operation and for investment of capital. In order to offset this disadvantage open hearth furnaces have been constructed in ever increasing size, and this development has in turn caused certain difficulties with which the steelmaker has to cope. These difficulties in the production of steel for cold drawn and cold rolled material have accentuated the importance of features which are common to all steel making; and in this industry the efforts to overcome the difficulties have been directed to the conduct of the Bessemer process and the material produced by it as well. These efforts may be briefly classified as having been directed to a thorough study of the conditions affecting

(a) Converting.

(b) The choice of deoxidizing addition or other alloys for the production of special results and the manner of their introduction.

(c) Pouring.

(d) Heat treatment for rolling both ingots and further derived forms, such as blooms and billets.

(e) The form and number of passes in rolling mills.

(f) The heat treatment in the process of wire drawing and cold rolling (annealing, etc.).

In the conduct of this work we have been at pains to employ not merely chemical research and practical experiment on a large scale under manufacturing conditions, but have established a metallurgical laboratory under trained investigators, equipped with the latest forms of apparatus brought out by the most advanced institutions of research in the United States and Europe.

ALLOY AND ELECTRIC STEELS

Among the newer developments in the wire industry affecting the quality of the material used which receive most careful attention is the introduction of the so-called

alloy steels for special uses in connection with the manufacture of wire rope, springs and parts of automobiles. In addition, what was until recently, if it is not still, the largest electric furnace in existence has been installed for the purpose of manufacturing by this entirely new process steels for a variety of wire products. The electric process makes it possible to obtain certain results, especially as regards the elimination of impurities in raw material, which cannot be attained by either of the other processes under which steel is made on a large scale; and it has been found that steel can be produced by this process at least approximating in quality that made by the crucible process at a cost which suggests the possibility of its use for purposes for which the cost of crucible steel is prohibitive.

IMPROVEMENTS IN GALVANIZED FENCE WIRE.

By far the most important single use for steel wire is in the manufacture of fencing. At the present time nearly one-half of the steel wire manufactured in the United States is used for this purpose, and the proportion of the total output so used is increasing steadily. Experience has taught that the only effective protection of steel against rusting, which can be applied commercially on a large scale, is the coating of the surface with metallic zinc in the process known as galvanizing. There has of late years been much discussion of the quality of the galvanized material supplied in all forms by the steel industry. This discussion has been participated in by consumers, by technical societies, by departments of the State and Federal Governments and by the manufacturers. There have been called in question both the quality of the steel used and the effectiveness of the protective coating applied. In our judgment, formed after most careful investigation, the quality of the steel has very little directly to do with the resistance to corrosion of a galvanized article, whether it be pipe, roofing sheet or fence wire. However, in every respect in which the quality of the steel may possibly have an influence on this feature care has been taken to eliminate unfavorable influences. We are convinced that the question of durability of galvanized material is almost altogether a question of the effective application of the zinc coating, and this subject has been given more attention than any other matter relating to the technical side of wire manufacture by the American Steel & Wire Comany. A brief statement of the conditions of the problem and the success attained in solving it may properly be introduced in an article such as the present.

The use of galvanized wire for fencing has a commercial history of about 35 years. At the outset, the wire was galvanized in the same manner as telegraph wire. This was satisfactory for a time because the demand was insufficient to compel the production of large output from manufacturing equipment; the wire was either used without fabrication, or formed into barbed fence, so that the heavy, comparatively rough coating was not objectionable; and the prices obtained were ample to afford a profit on the costly product. The growth of the demand stimulated efforts to increase production and to reduce cost so as to place the new product within the reach of everybody. Both objects were attained by the invention of the process of wiping the coated wire as it emerged from the bath of molten zinc. By this the consumption of zinc was lessened and it became possible, as it had not been with the old process, to increase the speed of the wires through the bath. Shortly thereafter woven wire fencing was introduced, compelling the use of the lighter coating of zinc formed by the wiping process because of the manipulations to which the wire was subjected in the weaving machines that cracked off the heavy coating formed by the old process. This had the effect of firmly establishing wiped wire as the standard product for all fencing purposes.

In this period of evolution the possible effect of the change in methods on the durability of the product was to a certain extent lost sight of. On the part of the manufacturers there was no intention of depreciating the quality. They were under the absolute necessity of meeting the demands of the woven fence makers for a smooth, thinly coated, galvanized wire, the quality of their product at the time it was sold being judged by its color and freedom from cracking or peeling of the zinc. The laws of corrosion and especially of the behavior of iron or steel in contact with zinc were imperfectly understood and it was not realized that in meeting the immediate requirements of users of galvanized wire there was being sown the seed of a crop of complaints in later years. These came from purchasers on account of the failure of wire fencing to last as long as they thought it should.

FEATURES OF THE NEW GALVANIZING PRACTICE.

This condition had come to a head at the time the American Steel & Wire Company was organized and the subject was given prompt attention. The process of galvanizing was made uniform at all plants, bringing each to the level of the best, insuring that the accepted standard of that time for first-class fence wire should be maintained. The complaints, however, did not cease, the Department of Agriculture and various State authorities becoming interested in the matter. It became apparent that a higher standard would have to be set, and we therefore instituted a thorough investigation with the object of devising means for materially improving the quality of the product without a prohibitive increase in cost. As a result of that investigation many features in the conduct of the process have been improved and the galvanized fence wire produced by the American Steel & Wire Company today is notably superior to the average product of a few years ago. The most important improvement consists in devising means for increasing the thickness of the zinc coating without rendering the product unsuitable for use in fence machines and this has been very successfully accomplished. In the course of the investigation leading to this result it has been necessary not only to study the galvanizing process but the effect of the composition of the steel on the process; and researches have been made, and are still in progress, into the metallurgy of zinc with a view to the production of metal best suited to this purpose.

In conclusion it is desired to state with the greatest possible emphasis that so far as we are concerned nothing is farther from the truth than the statement occasionally heard that quality of product is sacrificed to quantity. We have the clearest possible appreciation of the fact that the ultimate success of the American Steel & Wire Company as a business enterprise conducted for profit depends upon the reputation it establishes in the markets of the world for the excellence of its output.

AMERICAN STEEL & WIRE COMPANY,
CLEVELAND, OHIO. Wm. P. Palmer, President.

Automobile Demand Responsible for Much of the Improvement

Frankly, we believe that most of the steel companies are still running a race for tonnage and that some of them have not given the matter of higher quality much attention, particularly the companies making common steel by the Bessemer process.

Most of the companies making rails have given a great deal of time and attention to the improvement of the quality of rails. They have been forced into this position by the demands of the railroad companies and the public. Unfortunately the railroad companies demand a better quality of rails and are not willing to pay a higher price for them. Steel rails at the present time, considering the exacting nature of the specifications, are selling at too low a price.

The wonderful growth of the automobile industry in this country has probably had more to do with creating higher grade steel than any other factor. A small group of steel companies has in recent years given attention to the development of high grade steels, particularly in the alloy steels such as nickel, chrome nickel and chrome vanadium. The greatest development, probably, has been along the line of chrome vanadium steels. There is so much published giving the results of physical tests on chrome vanadium steel that it is scarcely necessary to repeat the data here. The automobile companies simply had to have a high grade steel for their gears, driving shafts, axles, drop forgings, etc. Formerly, they used to import alloy steel from Germany, and paid a very high price for it. In fact, some of them do yet, although they can get a better steel for very much less in this country.

Some of the steel companies have also developed some of their common grades of steel, thereby furnishing a bet-

ter product. The demand from the automobile trade has also brought out some so-called natural alloy steels, which are of a somewhat better grade than the ordinary open-hearth steels.

One of the greatest advances, however, has been in the widespread development of the heat treatment of steels. The consumers of high grade steels have learned to properly heat-treat them. The steel companies furnishing the higher grades of alloy steels have accomplished a wonderful work in teaching their customers how to use their steels and to get the best results by proper heat-treating methods. Nearly all of the larger consumers of high grade steels among the automobile manufacturers and other large industries now have complete heat-treating plants and skilled operators managing them.

The steel companies manufacturing high grade steels have all established modern heat-treating plants at their mills, and are furnishing their smaller customers with high grade alloy steels properly heat-treated, all ready for machining and use. This is a great advantage to the smaller consumers who cannot afford a heat-treating plant of their own.

The steel companies have been very broad-minded in giving out information concerning their steels, analyses, proper heat-treatment, etc. Years ago many steel companies made as much a mystery as possible of their analyses, manufacturing methods and heat-treatments. That day is past. The steel companies are taking the consuming public fully into their confidence.

To appreciate properly the advance that has been made in the development of high grade steels it is necessary to make a careful study of the tests now made possible by the use of chrome nickel or chrome vanadium steels, as compared with the steels available in a commercial way a few years ago. The higher tensile strengths, elastic limits, resistance to crystallization, machining qualities, etc., are in striking contrast with what was available some years ago.

The development of tool steels is another chapter, and should be written by manufacturers having had experience in that particular line, but the progress there has been rapid.

THE UNITED STEEL COMPANY,
CANTON, OHIO. Harry R. Jones, General Manager.

The Evolution of Quality in Wrought Steel Pipe

The production of welded tubular goods in this country has been doubled and seamless products trebled during the past ten years, and they now cover a much wider field of industrial life. Much has been written about the expenditures and plans to meet this growing demand by the construction of new mills. It may be of interest to review briefly what has been done in recent years regarding the quality of the product in connection with this expansion.

EARLY SHORTCOMINGS.

Prior to this period the early history of steel pipe dating from 1887 was one of keen competition and more or less irregularity in product, and the condition was made worse through the manufacture of a lighter weight by some mills; in fact, there was no uniformity in standard. The pipe mills in those days had to buy their material in the open market from mills making many other varieties of steel and, therefore, did not have sufficient control over the quality. In case of the skelp proving defective no detailed information existed as to its history by which the trouble could be prevented in the future and adjustment of claims was always difficult and uncertain. Shortly after the formation of the National Tube Company all the mills which came under the new management were required to work to a new standard weight for merchant pipe, somewhat lighter than card weight, but considerably heavier than the average produced before its adoption; and from time to time since the adoption of this standard we have increased the weight, until now in the case of all pipe larger than 6-in. in diameter, as well as all sizes of extra strong and double extra strong, we have abandoned the light weight and use nothing but card weights. While we are of the opinion that nothing but full card weight should be made, it would be too radical a departure for one company to undertake alone; but in order that buyers may know what they are getting when they order merchant weight we have published the merchant weights on all sizes where made. For some time we have been rolling our name in lap weld pipe, and having finally found a method by which butt weld pipe may also be marked without injury we started January 1, 1912, to put this into practice.

It was clearly demonstrated through experience in these early years that to make a uniform satisfactory quality of welding steel it was necessary to have control of every operation from the ore and coke through to the finished pipe, and furthermore to maintain the highest standard of quality the plant should not only be self-contained and independent of any outside supply of skelp, but should make this grade of steel exclusively. It was found impossible to regulate the supply of skelp purchased outside by specifications or inspection. Accordingly, about ten years ago the Lorain and National Works of the National Tube Company were designed and have since been completed with this end in view. These large groups of mills were the first of their kind to be constructed and contain the most favorable facilities for tracing material through the various departments, so that the conditions necessary for the study and control of quality are all that could be desired.

In order to separate the questions of quality from tonnage as far as possible, all the welders in the finishing mills are paid on a salary basis in distinction from the usual system of paying according to tonnage produced which prevails in rolling mills and steel works. Further, the lower departments (blast furnaces, steel works and rolling mills) are required to make the steel under orders and specifications from the tube and pipe mills; any material which proves defective is charged up as scrap against the department responsible for its failure.

UNIFORMITY OF PRODUCT.

With this system of close and friendly co-operation all through to the finishing departments, where each piece is carefully tested by itself, it has been found possible to increase considerably the efficiency of production as a whole and at the same time give the customer a more uniform product better adapted to whatever service it is intended for. It is a well-recognized fact that uniformity in chemical and physical properties is of special concern in respect to the corrosion of pipe and its manipulation.

The soft steel made for welding in these mills under this system of control varies not more than 0.005 per cent. in carbon in any heat. For many purposes the uniformity of each heat is checked by comparing the manganese in the last few pounds of steel teemed out of the ladle with the average ladle test. Over 98 per cent. of such heat tests show a variation in manganese of less than 0.04 per cent.

The steel has been further improved in the matter of uniformity and made more resistant to corrosion by means of a new process of rolling whereby the surface of the metal is knobbed and rendered more uniformly dense.

TESTING AND INSPECTION.

The tube and pipe business requires a close inspection and testing of each piece before shipping; this is the final and perhaps most important check on quality. Along this line, special facilities in the way of better lighting in the mills have made surer the work of surface inspection. All tubes and pipe are tested under 500 to 3000 lb. internal hydrostatic pressure, according to the dimensions and use for which they are made. The test pressure has in the past few years been more than doubled in some cases. On certain classes of goods, such as California casing, drive pipe, drill pipe, line pipe, tubing and all pipe to be used for flanging and bending, the crop ends are crushed down after being cut off and all pieces which fail at the weld or in the material are rejected. In the case of boiler tubes this testing of the ends is carried out more rigidly; and for locomotive tubes, which are subject to the greatest strain in service, a machine has been designed to turn a flange on each crop end, in addition to the flattening test. This means that each tube must pass as severe a test as to quality of material and weld as was formerly required of one tube out of each lot of from 100 to 250 tubes under the standard specifications of the railroads.

GREATER RESISTANCE TO CORROSION.

We have found it desirable in order to meet requirements of the trade as far as possible to conduct thorough researches with a view to better adapting the product to certain uses. One of the first problems attacked about nine years ago was that of corrosion. The influence of mill scale in causing pitting was found to predominate, but the benefit of uniformity and sufficient hot work was also clear. Our process of making the steel was worked out with these results in mind. Experiments in the laboratory and field under service conditions have fully demonstrated that steel so made is somewhat less corrodible than real puddled iron and less liable to pit. With these points settled in our mind, there remained no good reason for continuing the manufacture of wrought iron, so that our whole attention has been lately concentrated on the manufacture of steel. It appears quite probable that more than one grade of steel will, in the future, be made for corrosion, depending on whether the conditions happen to be acid or neutral.

TESTS FOR INCREASING STRENGTH.

Other extensive researches were conducted by Prof. R. T. Stewart, of the University of Pittsburgh, at our request on the collapsing strength of steel tubes, the physical properties of carbonic acid, internal pressure, column and torsional strengths and other matters relating to tubular goods, which have been of real service to the trade, accounts of which will be found in the Proceedings of A.S.M.E. Tests have been made on full-sized sections of pipe to determine the strength of threaded joints, resulting in improvements better adapted to particular conditions. Torsional experiements are also under way to develop the strength of rotary drill pipe joints with a view to overcoming some of the difficulties which drillers have to contend with.

As a result of these investigations on cylinders for carrying carbonic acid, oxygen and ammonia an apparatus has been constructed for testing these to a high pressure in a water jacket by which the expansion and permanent set of each cylinder may be measured. Thus a weak cylinder may be detected and greater safety secured.

A HIGHER STANDARD FOR SEAMLESS TUBES.

Seamless tubes have also been raised to a higher standard, particularly through the more general use of the hot finish process, by which a considerable portion of our seamless product is now made. Where cold finishing is required it does not involve so much cold drawing. The advantage in avoiding unnecessary internal strain and repeated annealing and pickling operations is obvious.

In conclusion it may be said that the main advance in the standard of quality of our tubular goods has been through an endeavor to maintain the highest standard of uniformly good quality, which is particularly desirable in tubes and pipe, since it results in both higher efficiency in manufacture and better service to the consumer.

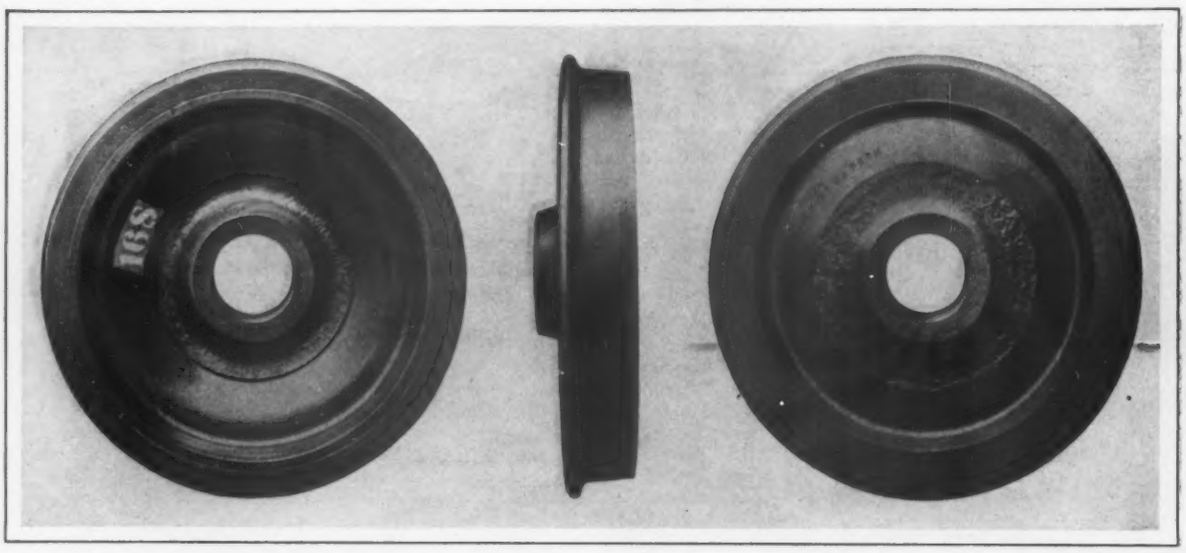
THE NATIONAL TUBE COMPANY.

PITTSBURGH, PA. Frank N. Speller, M.E.

The Work of the Carnegie Steel Company on Higher Quality Steels

There is no reason, technical or practical, for believing that large tonnages necessarily indicate deterioration in quality. There is, however, a best rate of production; a variation from this, either above or below, tends to interfere with best quality.

The progress which the Carnegie Steel Company has made to insure its customers receiving the quality suitable to the work in hand is perhaps chiefly found in the perfection of its inspection service. This is conducted by the best technical talent available, and its operations are definitely and completely severed from the operating forces at the mills. The noteworthy things which have been accomplished to supply American designers and users with materials of high quality are best illustrated by a description of the various steels which are now developed and obtainable in quantities to suit the demand.



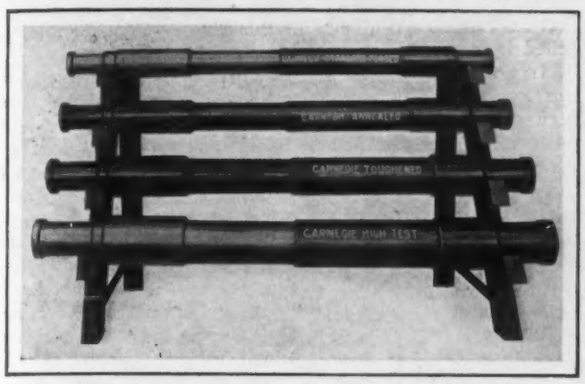
Schoen Forged and Rolled Wheels

For structures calling for steels of greater strength than that formerly employed, the Carnegie Steel Company has developed nickel steel, which can be furnished in eyebars, plates or shapes, with an ultimate strength of 70,000 to 90,000 lb. and an elastic limit equal to 55 to 65 per cent. of the ultimate. Special alloy steels have been brought out through the combined efforts of the special engineers engaged in research and practical operators trained to make accurate observations.

ALLOY STEELS

Probably the most interesting feature of all this work which could be written about at this time would be found in the following description of alloy and other steels, details of which are found in the publications of this company.

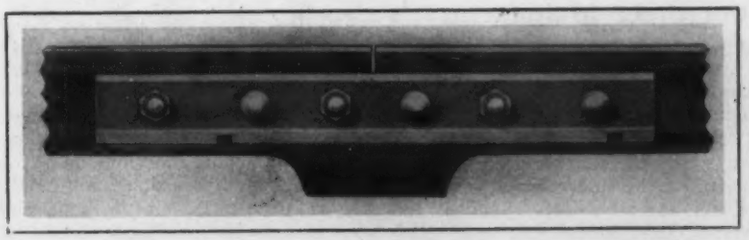
Where very severe conditions were to be met and it was impracticable to use a larger section to obtain the necessary strength, the ordinary heat treated carbon steel was improved by the addition of one or more metals, producing an alloy steel. Some of the well known alloy steels are nickel steel, chrome-nickel steel and chrome-vanadium steel. Owing to their higher cost, they have not been universally adopted for ordinary purposes, but their consumption is increasing, especially where weight or size coupled with great strength is an important consideration.



Four Classes of Heat-treated Axles

Alloy steels are always heat treated to develop their best properties. They are as a rule more sensitive to thermal influences than carbon steel, and require more careful handling to obtain the highest efficiency. This feature is becoming well known to the consumers of these steels.

At some of the Carnegie plants a great deal of attention has been given to supplying the trade with treated alloy or carbon steels of the medium grades. Nickel steels of various grades have been furnished by this company for many years for boiler and deck plates, bridge material, armor, axles and forgings. Within a few years they have been furnishing vanadium steel, either as vanadium alloyed with the steel, or as vanadium - chrome or vanadium - nickel-chrome steel. The properties claimed for the vanadium alloy steels are their great strength and toughness, the high ratio of their elastic limits to their ultimate strengths and their great resistance to failure under repeatedly applied dynamic stress. They have met certain special engineering conditions where the demands of repeated application of stresses have required great resistance to failure, as in the design of locomotives, automobiles, bridges and parts of moving machinery. The demand for these alloy steels in the arts is increasing. They are furnished to the trade in seven types, as follows:



Heat-treated Rail Joint

Type A—For cylinders for gases, hammer rods, automobile axles and crank pins.

Type D—For pinions and gears, springs, valve motions and motor parts.

Type E—For rivets and tubes.

Type F—For firebox and boiler plate.

Type H—For drills, shear blades, dies and chisels.

Type K—For drop forging dies, saws, ball races and railroad springs.

Type S—For eye-bars, automobile frames, locomotive and freight car axles, connecting rods and piston rods.

The elastic limit in these alloy steels is from 70 to 90 per cent. of the ultimate strength, while the ductility is high. It can be obtained with elastic limits ranging from 30,000 to 180,000 lb. per sq. in.

HEAT-TREATED AXLES

On account of its great ductility wrought iron, or soft steel, was formerly considered the most desirable material for axles, until it was demonstrated that breaking was due as a rule, not to lack of ductility, but to the fact that the stresses too nearly approached the elastic limit. In the light of this knowledge, axles have for some time been made of a fairly hard grade of steel, and for ordinary service standard forged axles, without any special heat treatment, have given good satisfaction. However, with increased loads and particularly with the very severe conditions imposed on motor axles, a better grade of material has been sought which shall have higher resistance to stresses and still be sufficiently ductile to insure freedom from brittleness. This has resulted in the evolution of the heat treated axle. This company has installed a very complete plant for heat treatment of axles and is prepared to furnish treated axles, annealed, toughened, or of a variety known as "high test," in which the elastic limit and ultimate strength have been increased from 30 to 60 per cent. over the untreated axle, while the toughness, as measured by the elongation and reduction in the pulling tests and by the number of twists in the torsion test, has not been decreased. Heat treated axles are now being furnished in these classes, depending on what the demands of the user may be. It is believed that the extra expense is repaid several times by the increased strength and safety obtained.

During the past year a new shop for the production of rail joints, commonly called splice bars, has been completed. The plans included a complete plant for heat treatment. Formerly all rail joints were made of wrought iron, or soft steel, as it was believed that the material must be very soft and ductile to avoid breakages. As the traffic increased and the loads became heavier, the joint would not sustain the load. Various remedies such as new designs, harder steel, heavier sections and heat treated material are being tried by engineers with more or less success.

An exhaustive set of experiments was started to determine, if possible, what results could be obtained by heat treating the bars. These experiments, some of which are not yet complete, covered the ordinary physical, mechanical and chemical examinations, and the attempt to reproduce, so far as possible in the test, the actual service conditions in the track.

By selecting steel of the proper composition and heat treating it to give the highest results, it was possible to obtain a steel of from 80 to 100 per cent. greater elastic limit and ultimate strength than the earlier bar. The full sized joint when tested was from 100 to 150 per cent. stronger than that formerly used, while the tests to imitate track conditions showed that while it required a greater force to deflect the joint, it resisted the repeated alternations of force much longer before showing signs of failure.

Engineers are now specifying harder steels for this class of work than in the past. Some specify that the material must be put into a ductile condition by heat treatment after fabrication, others that the material is to be treated so as to give it the greatest stiffness. To meet this demand, this company has prepared itself to furnish, at some extra cost, almost any grade of material desired by the purchaser.

Vanadium Steel Driving Axle 10½ in. Diameter

FORGED AND ROLLED STEEL WHEELS

The capacity of freight cars has been limited to the kind of wheels which could be obtained economically. The necessity of increasing the capacity of these cars resulted in the development of the Schoen forged and rolled steel wheels. Good factory practice has enabled us to place on the market the Schoen wheel which today meets in every way the requirements of this class of trade at a price that makes it desirable for railroads to install them under all cars of 100,000 lb. capacity and over. Cars of lighter capacity, especially those that may get into high-speed service, can and do use these wheels to advantage.

As an illustration of the popularity of these wheels, there are now in service under freight cars 450,000 wheels. These wheels give every indication of running ultimately from 150,000 to 200,000 miles, with practically no expense for maintenance. These wheels are especially desirable where quick acceleration is of importance. Such service as this is almost absolutely necessary in the subways of our large cities. They are also especially desirable on trolley-roads, both city and interurban. The particularly desirable feature of these wheels in this service is their freedom from the defect which is so prevalent in cast iron wheels, namely, flat spots. The familiar and distressing thump, thump of the old-fashioned wheel is almost entirely eliminated where trolley-roads have adopted steel wheels.

THE CARNEGIE STEEL COMPANY.

PITTSBURGH, PA.

Some of the Tool Steel Manufacturer's Recent Achievements

While we are interested in everything pertaining to steel we are more than interested in comparisons between quality of foreign and American tool steels. We will admit that for a great many years the American steel manufacturer was not as careful as he might have been with the quality of his product; but all this is changed, and to-day there are makers of steel in this country whose product will equal, and in some instances excel, that of any plant in Europe. To-day the American manufacturer knows the importance of uniform stock. He knows that uniformity of his raw material is absolutely essential to success; but he has also learned by experience and observation that even good uniform material will not give him uniform product unless care is exercised through all subsequent operations of melting, hammering, rolling and annealing. The best raw material in the world can be spoiled by over-melting. The higher the temperature of the molten bath the greater will be the percentage of nitrogen and oxygen absorbed; consequently if care is not taken in the melting all the pains taken afterward will be of no avail. Each operation of hammering, rehammering or rolling must receive the same amount of care, as it is necessary that the ingots be carefully heated to avoid over-heating, and extreme care must be taken that the finishing heats are not much above the hardening temperature of the steel. Take, for instance, a billet of tool steel containing 1 per cent. carbon. If this billet is heated to, say, 1800 deg., and is finished at 1600 deg., it will not harden as well, nor will it make as good a tool as a billet heated to 1500 deg. and finished at 1400 deg. And so on down the list. Each operation must be followed carefully so as to avoid high finishing heats.

UNIFORMITY IN ANNEALING.

Next in order is the annealing. With the best pyrometers at our disposal it is possible to produce the most uniform results in annealing. The indicator is placed near the annealing furnace for the guidance of the annealer, and a recording pyrometer is placed in the office of the superintendent, which gives him a careful record of temperatures during the entire time consumed in annealing; so that when a certain temperature is found to be the best for a particular purpose no trouble will be found in obtaining the same results to-day or next year.

Nothing is left to chance. There is no guessing. No short cuts as in former years. The advancement that has been made along the line of care in the United States during the past six or seven years is remarkable, and there is absolutely no necessity to-day for any tool steel user going outside the United States for his steel, as we know that he can secure quality in this country that is not excelled by any maker abroad.

It would be well for the skeptical to visit the plants in this country and familiarize themselves with what has been done and the care that is taken in order to produce uniformity; and the satisfied tool makers in this country are the best recommendation that the American product can possibly have. We have chemists who are as painstaking as any educated in Europe. We have metallurgists who are just as well posted on matters pertaining to metals as any in the world; and we have tool workers who, through careful training during the past few years, have been taught the importance of uniformity and careful heating and finishing of tool steel. So naturally we feel that our product is equal to any.

The careful American tool steel manufacturer is always experimenting, not as formerly, by rule of the thumb, but scientifically, making careful notes as the experiment progresses, so as to reproduce results should they prove of benefit to his product.

GROWING USE OF ALLOY STEELS.

Five or six years ago it was possible for tool steel plants in this country to satisfy their trade with two or three brands of carbon steel. To-day there are so many combinations of chrome, nickel, vanadium, tungsten, molybdenum, silicon and manganese that it is a difficult matter for even the manager of the works to remember all the brands he makes. We have steels that do not shrink when hardened; steels that cut metals at such a rate of speed as to be almost unbelievable as compared with the old carbon steels; steels that do not require any hardening, but are simply heated to a certain temperature and then allowed to cool in the air, thus avoiding distortion in the hardening process. We make steel that will show 165,000-lb. elastic limit and can be almost bent Norway iron, with practically the same elongation; steel that will support nine tons on 1¼-in. round, 10-in. centers, without any distortion; and we have a steel that will show 165,000 lb. elastic limit and can be almost bent double on itself without breaking. Hence we think it is high time that we use the label "Made in America."

VULCAN CRUCIBLE STEEL COMPANY,
ALIQUIPPA, PA. Samuel G. Stafford, President.

The Development of "Improved Iron" Sheet Products

Present day ferrous products in sheets may be classified as follows:

1. Steel, Bessemer and open-hearth.
2. Iron, wrought, or the so-called charcoal iron.
3. The "improved irons."

The improved irons are really not iron as generally classified, and while in some points the analysis bears a resemblance yet the ductility and general workability are equal, if not superior, to the best open-hearth steel. In the manufacture of our own product we deemed it fair to use a neutral name—Toncan metal—rather than to call it iron. It works up admirably, galvanizes without the blistering which is characteristic of iron, or without going into solution as does steel, in the galvanizing pot. Our experience with Toncan metal in actual service includes plates, sheets, roofing, nails, rivets and some wire, over a period of more than four years. We erected a stack of No. 11 gauge black Toncan metal sheets in 1908, and this has been in continuous service since then as a conductor of gases, fumes and smoke from a battery of four galvanizing kettles. It is as solid to-day as when erected, and corrosion has never really affected it. A steel stack of the same gauge, and which was painted two or three times on the outside, has been replaced and a second steel stack is standing to-day. This second stack performs exactly the same functions as the other, and both the original steel stack and the one in replacement continually cast off great flakes of scale. The Toncan metal stack has never been painted and has not been favored in any way.

In November, 1908, we erected a "test fence" on the roof of our galvanizing plant, where the conditions are extraordinarily severe and on the fence placed uniformly shaped samples, all of the same gauge and size, of steel, puddled iron, muck iron, common iron (made of scrap in a busheling furnace), charcoal iron, and Toncan metal.

There is one conclusion which can be drawn with absolute assurance—the protective effect of a galvanized coating applied by the hot process is beyond doubt.

In addition, we find the Toncan metal, either black or galvanized, invariably in better shape than the steel, plain or galvanized, and the puddled iron, which is not galvanized or galvanizable; also in better shape than the black or uncoated steel. However, the samples of galvanized steel are far ahead of the puddled iron in this test.

The elimination of impurities and gases to an unheard of degree, the scientific heating of the metal at every stage of manufacture, and the slow rolling and careful annealing to remove strains, all combine to make a very dense homogeneous metal, neither iron nor steel, according to any generally accepted definition, and in its service greatly resembling the ancient irons. A good base is worthy of the best protection and when this product is galvanized with a heavy coating of spelter, free from dissolved iron, we have something which comes as near to durability as we have ever had or shall ever achieve, bearing in mind that any product made on a ferrous base will eventually return to dust.

THE STARK ROLLING MILL COMPANY,
A. T. Enlow.

CANTON, OHIO.

Improvement in Quality of Rail Steel

In the following paragraphs are given some details of alterations in steel making methods made by the Lackawanna Steel Company during the last few years with particular reference to the question of retaining, and if possible improving, the quality of rail steel. Lackawanna rails have always enjoyed a splendid reputation, more especially those made at the old Scranton mill. It was felt that this good reputation must be lived up to, and accordingly active experimental work was begun about six years ago. The increasingly heavy requirements that the rails had to meet demanded a steel fully equal, if not superior, to that of the old rails. Needless to say, these requirements are still steadily increasing.

LINE OF INVESTIGATION FOLLOWED.

A careful comparison of the methods in vogue in the manufacture of steel ten years ago as compared with the process of 1907 determined that the element which had suffered the greatest change was that of time, as the introduction of mechanical appliances and devices through the process had greatly increased the rate of production and had therefore left less time for each individual operation. With the aim in view of first determining whether or not this element of time did play an important part in the quality of the products produced and, next, to make such changes in the methods as would permit a return as near as practicable to the old conditions, should the investigations prove that such were advisable, the following procedure was pursued:

Very careful microscopical tests were made daily for several months on finished rails from heats that had been followed from the pig iron mixer to the hot saw. In other words, their metallurgical life history was completely known. In many cases it was found that the rails were permeated by threads of a slag-like substance, which it was at once decided must be eliminated, as it was undoubtedly the cause of much of the trouble. These threads and bands were evidently due to the elongation by rolling of material contained in the ingot, so that the question resolved itself into the production of ingots of clean steel. Extensive experiments were begun, controlled by careful metallographic and physical testing. It was found that by adding the spiegel mixture to the blown metal in the converter and holding for a short time great improvement was brought about. Also the use of a smaller nozzle in the steel pouring ladle, with consequent slower pouring, was of great assistance.

The theory worked upon was that the manganese and silicon of the spiegel mixture react with the oxide of iron in the blown metal and form oxide of manganese and silica. The oxide of iron is soluble in the blown metal, but these two new oxides are insoluble, so they are precipitated and naturally occur in a very fine state of division. Time must be given for them to collect together and separate from the bath of steel, which separation is helped by their low specific gravity. The conditions in the converter, with its white hot lining, are the most favorable for these reactions.

FEATURES OF THE NEW PRACTICE.

Accordingly, this was worked out to the following which was adopted as standard practice: The pig iron from the mixer is blown in the usual way, and as soon after turning the vessel down as possible, the accurate amount of spiegel mixture is added. The heat of steel is then held for a definite time in the converter and poured into the steel ladle, which is swung over the ingot molds and the steel poured through a small nozzle.

Shortly after this practice was put in operation the ferrotitanium alloys were introduced, and careful experiments were begun at once. It was found that our conditions were very favorable for obtaining the maximum results from the alloy. The only changes in the above mentioned standard practice are that the alloy is added to the steel as it enters the steel ladle from the converter, and then the metal is held for a definit time in the ladle before pouring. The proper length of time is fixed at what has been found to give the best results. The final result has been the production of steel that is still more solid than the plain steel and gives better results.

This one particular instance, that of the Bessemer rail steel, is given to show the care and attention that are being paid to the details of the steel making process. The most modern methods of testing are being used, and the results are being applied in practical ways.

THE LACKAWANNA STEEL COMPANY.

BUFFALO, N. Y.

The New Requirements Met by American Saw Steel

We appreciate the opportunity of expressing briefly our views with reference to the quality of American made steel. It cannot be successfully contradicted that America is not only the largest consumer of steel in the world, but also the most critical consumer, and of this vast consumption the imported part is almost infinitesimal.

These facts should be sufficient to successfully establish the claim that the best American steel is equal, if not superior, to that made in any other country in the world. This is not only true of rails, plates, structural steel, wire and the commoner grades of steel, but equally true of the higher grades of steel as tool steel and alloy steels. The firm of Henry Disston & Sons, for the manufacture of saws, undoubtedly uses a greater quantity of tool steel annually than any other single American manufacturer. The utility of saws is probably 50 per cent. greater to-day than ten years ago and probably 20 per cent. greater today than three years ago, which demands that saws must to-day be an equal percentage better. It is therefore not only a fact that the saws have been greatly improved by scientific heat treatment and tempering, but the steel from which they are made has been greatly improved during the last few years.

MATERIALS FOR TOOL STEEL FOR SAWS.

An experience of 56 years in the exclusive manufacturing of tool steel for saws has demonstrated that the highest grade of steel must be made from:

1. The best grades of charcoal iron. We therefore use Swedish brands.
2. The material must be thoroughly melted. It is therefore melted from four to five hours in plumbago crucibles.
3. Segregation must be prevented or reduced to a minimum. The steel is therefore cast in molds of proper form and size to permit of proper cooling.
4. Steel must be sound. Years of experimenting at great expense have proved to us that compression is not satisfactory. We therefore cast ingots in such shape and form as to eliminate pipe and unsoundness by gravity.
5. Steel must be carefully heat treated. The heating for hammering, rerolling or reworking is therefore scientifically controlled.
6. Alloy steels. For saws for specific purposes we have greatly improved the quality by the addition, according to the requirement, of certain alloys—tungsten, chromium, vanadium, silicon, manganese, aluminum, magnesium and other elements.

For instance, take the large circular saws of to-day. Not many years ago they were run at about one-third the speed to-day; quite a number having the logs fed to the saw by hand, while they are now using steam power in obtaining what is termed "shotgun feed." Again, while the feed to-day is so many times greater the saws are made much thinner or lighter gauge, thus requiring a higher quality of steel. In the matter of band saws, they are now extraordinarily thin; the width has been greatly increased and the saws run at a greater velocity. These band saws require a special long grain steel possessing elasticity, ductility and above all durability to withstand the bendings and straightenings caused by running around the wheels of the bandsaw machine, and also the sudden jars on its first contact with the cut. When you consider that the larger band saws travel about a mile and a half per minute—or faster than the fastest express train—you will have some idea of the strain involved.

MANIFOLD DEMANDS UPON SAW STEEL.

Demand on the part of the lumber manufacturer for increased output caused untold difficulties for the saw manufacturer. For this forcing of results in the saw mill necessitated the making of a steel which would withstand the much greater strains and at the same time have longer life.

Summing up, there is no other article of utility made of steel which requires a higher grade of steel possessing such tensile strength, ductility and elasticity, one which is capable of receiving and holding a high temper, which will maintain its tension and, paradoxical as it may seem, be so hard that it will withstand the wear and retain its sharp edge the longest possible time, yet tough enough to set or swage readily and perfectly without flaw—hard enough to require force to bend and at the same time so tough that it will bend almost flat upon itself if necessary. Consequently steel for saws must be of a peculiar and high quality; and from our experience there is none which compares with the American product of to-day.

HENRY DISSTON & SONS,
PHILADELPHIA, PA. E. B. Roberts, Treasurer.

Avoidance of Segregation in Plate Steel

The character of our product does not naturally deal with ferroalloys. We have done some little experimentation in that direction during recent years, endeavoring to ascertain what benefit could be obtained in the way of solidification of steel and avoidance of segregation, etc., but have nothing to report in this line.

We have, however, found during this process of study, part of which is illustrated in the accompanying pamphlet (a paper which I presented at the meeting of the Society for Testing Materials), that considerable benefit could be obtained in the general working conditions in melting and heating, as well as in rolling, to secure more uniformity of high quality in boiler plate steels, and in consequence most of our efforts have been along this line during recent years.

LUKENS IRON & STEEL COMPANY,
COATESVILLE, PA. Charles L. Huston,
Vice-President.

What Has Been Done by American Tool Steel Makers

Browning speaks somewhere about the glint of the pebble in the sand which catches your eye from a long distance ahead, making you ignore the ones which lie at your feet. If tool steel were made in the moon there are lots of people who would want to get some of it and lots of people who would swear by it, even if the quality were so bad that they really should swear at it. When I was a boy working in a machine shop, I remember the marvelous story about the Frenchman who took an ordinary brass pin and drilled a hole through the entire length of it. This made us feel very crude and we imagined that all Frenchmen were capable of the finest kind of workmanship.

In the first place, there is no reason why a hole should be drilled through a pin; but if there were reasons and if there were enough wanted to make it worth while, the American would go at it differently. He would build an automatic machine into which the pins could be dumped by the shovelful and they would come out perfectly drilled, cleaned, sorted and packed in boxes, so many to the box. That illustrates the difference.

There has been more progress in the manufacture of steel during the last 50 years than during the entire period of 5000 years before, and America has taken the lead. America has brought out men of skill and men of daring, men who were brave enough to discard half a million dollars' worth of machinery not over five years old and put in something at a greater cost and more up to date. It is hardly necessary to say anything further in this connection. It is so apparent to anybody who is at all posted. American tool steel makers have progressed as much as the open hearth steel makers.

There is much talk about the traditions of the trade being handed down in Europe from generation to generation. One has only to come in touch with the stolid and stupid European workmen and compare them with the intelligent class of men to be found in American steel works to overthrow any such theory. Then, there is the disposition in Europe to jealously guard little secrets of the trade, most of which are at best of questionable value, and the result is to keep new knowledge out of their works instead of keeping the old knowledge in. There is a law still on the statute books in England imposing a penalty of two years imprisonment with or without hard labor, or a fine, or both fine and imprisonment, on any person who improperly discloses trade secrets. In other words, the policy was to fine and imprison any one who tried to meet with other people in the same line and effect an interchange of ideas for the general advancement of the trade.

Fuel costs and the restricted output of the mills in Europe makes it out of the question for them to compete with the American tool steel makers on an equal basis. They must either put a fancy name to their steel and get a fancy price for it or else they must substitute a lower grade for the same price.

I noticed an article the other day in *The Iron Age* referring to some French steel; and, although I do not exactly remember the wording, it was in effect that at last there was a French concern which really had a steel with some merit and was doing business on the square. The impostors who covered this country a few years ago have brought disrepute to all French steel makers. In addition to this, our plant alone produced more tool steel last year than was made in all France, and we are far from being a large concern.

I also understand that there is a large amount of open hearth steel being dumped in this country at present under the name of tool steel, and I presume they will reap their harvest the same as the Frenchmen reaped theirs. The American steel maker is not only much more intelligent and much quicker to investigate new ideas than his European competitors, but he is an engineer of wide and varied experience. He makes it his business not only to understand his own methods of manufacture, but he informs himself to the last detail on the requirements of his customers. The result is that he brings to bear upon the tool steel business a rare faculty of judgment in selecting the kind of steel best adapted to each requirement. A tool steel may be of wonderfully good quality, but if it is not adapted to the purpose, the result will always be disappointing. The American tool steel manufacturer is close to the consumer and studies his requirements much more carefully than is generally understood. The European manufacturer is so far away from the market that it is a hit or miss proposition. His product cannot be adapted to individual requirements.

We have never yet analyzed a piece of European tool steel which could not be duplicated or excelled in this country by any one of half a dozen leading tool steel makers, and in addition would probably be sold at a lower price. There is more tool steel made in the United States in one day than all of Europe produces in a week.

The Americans have been too modest. They have allowed the trade papers to be flooded with a lot of talk along the line of the Frenchman who drilled the hole through the pin. Perhaps it is the tool steel maker's own fault, but he is wrapped up in his own achievements and his time has been given to perfecting his product and holding it up to the highest standard rather than blowing his own horn.

There was no tool steel made in America to amount to anything up to the middle of the last century and before that all of our tool steel came from Europe. That naturally built up a prestige; but it is about time for Americans to consider something else besides the past. There is a proverb in German in effect that if a man has a reputation for getting up early in the morning, he can lie abed as late as he wants to.

Now, in proof of all the above, if there is any one who reads this article and who thinks he is obliged to use imported tool steel, let him write to me personally and I will tell him half a dozen concerns that will give him as good or better steel at a lower price. If it were possible to establish inspection laws, similar to the pure food laws, governing the importation of tool steel, the gullible American consumers would be protected from the invasion of the wily Frenchmen or those who bring open hearth steel over here and try to sell it for crucible tool steel at or near the crucible tool steel price.

COLUMBIA TOOL STEEL COMPANY,
CHICAGO HEIGHTS, ILL. E. T. Clarage, President.

More Rigid Specifications Met in Boiler Steel

While we have always made a speciality of quality and finish, and particularly during the past 10 or 12 years have devoted our attention to the production of high grade steels, making a specialty of stationary boiler, locomotive boiler, marine boiler and locomotive fire box steel plates, nevertheless, as you assume, during the past two years, when demands upon us have been but moderate and at time very slack indeed, we have been endeavoring to attain still higher results, and if possible produce even better and more varied qualities of steel plates. We are pleased to report that we have proved our ability to make, to the best of our knowledge, steel conforming to all of the standard specifications current for sheared steel plates for various structural purposes, stationary boilers, locomotive boilers, marine boilers, A. B. M. A., still bottom, welding steels of various kinds, hull plate fulfilling the different specifications for vessels, tank, boiler, and locomotive fire box, conforming to the various specifications of the prominent railroads and locomotive builders throughout the country, and all classes of plates as required for various purposes by the United States Government, including high tensile steel plates for boats, and excepting only nickel steel and armor plate.

WORTH BROTHERS COMPANY,
COATESVILLE, PA. L. F. Nagle,
General Sales Agent.

More Exacting Demands Met in Sheet Steel Products

It may interest you to know that the many new uses to which sheet steel products have been put during the past few years have made imperative the adoption of steels of special analyses. In addition, high finishes have followed as a necessary adjunct to these special grades, in order to produce satisfactory materials for the manufacture of, for instance, steel cars, automobile parts, electrical equipment, steel barrels, metal furniture, steel lath, household articles, and many other lines in connection with which wood and other commodities were heretofore largely employed.

To satisfactorily meet exacting requirements of these specialties the steel manufacturer has been obliged to spend large sums of money to provide the necessary means looking toward quality rather than quantity. Completely equipped research laboratories, technical experts in both the steel producing and finishing departments, to say nothing of a specially trained corps of inspectors, are some of the features introduced to solve the problem of quality, so essential in this rapidly moving epoch of new ideas involving the extensive use of metals, which are every day displacing materials of frail construction, thereby promoting permanency as well as safety.

THE AMERICAN SHEET & TIN PLATE COMPANY,
PITTSBURGH, PA. E. W. Pargny, President.

[An article by the Pennsylvania and Maryland Steel Companies dealing with their Mayari steel, contributed as a part of the discussion on the "Improvement in the Quality of American Steel," will be found on other pages.—Editor.]

November Iron and Steel Exports and Imports

The report of the Bureau of Statistics of the Department of Commerce and Labor for November shows an increase in the exports and a decrease in the imports of iron and steel, as compared with the figures for October. The total value of the exports of iron and steel and manufactures thereof, not including iron ore, was $21,547,399, as compared with $20,799,591 in October, while the value of similar imports was $2,026,789 against $2,443,023 in October. The exports of commodities for which quantities are given totaled 186,557 gross tons in November against 185,392 tons in October. The details of the exports of such commodities for November and for 11 months of the year ended with November, compared with the corresponding periods of the previous year, are as follows:

Exports of Iron and Steel.

	November.		Eleven months.	
Commodities.	1911 Gross tons	1910 Gross tons.	1911 Gross tons.	1910 Gross tons.
Pig iron	8,147	20,875	109,858	115,966
Scrap	4,406	2,555	73,929	21,109
Bar iron	1,581	949	16,668	16,929
Wire rods	2,510	1,857	18,716	21,297
Steel bars	8,674	9,682	111,954	99,324
Billets, ingots and blooms	13,871	17,695	216,832	47,350
Steel rails	25,140	28,263	398,000	311,587
Iron sheets and plates	16,175	9,660	114,691	94,168
Steel sheets and plates	22,584	16,194	213,820	157,311
Tin and terne plates	5,056	2,455	54,729	11,402
Structural iron and steel	28,174	8,909	205,765	133,403
Barb wire	13,879	10,134	88,741	72,904
All other wire	11,817	10,337	118,454	85,125
Cut nails	1,492	1,155	10,475	7,633
Wire nails	4,462	2,692	44,602	38,610
All other nails, including tacks	1,168	1,103	12,132	9,436
Pipe and fittings	17,421	10,212	180,897	142,480
Totals	186,557	154,727	1,990,263	1,386,034

The imports of commodities for which quantities are given totaled 13,561 gross tons in November, as compared with 19,992 tons in October and 40,582 tons in November, 1910. The details of such imports for November and for 11 months of the year ended with November, as compared with corresponding periods of the previous year, are as follows:

Imports of Iron and Steel.

	November.		Eleven months.	
Commodities.	1911 Gross tons	1910 Gross tons.	1911 Gross tons.	1910 Gross tons.
Pig iron	8,346	20,427	134,664	217,322
Scrap	146	1,293	16,622	70,143
Bar iron	1,943	2,846	25,122	35,726
Billets, bars and steel plates n.e.s	1,503	5,677	28,106	44,784
Sheets and plates	138	298	2,074	5,967
Tin and terne plates	246	8,058	1,369	63,530
Wire rods	1,239	1,983	14,337	18,924
Totals	13,561	40,582	222,294	456,396

The imports of iron ore in November were 128,019 gross tons against 172,459 tons in October and 197,833 tons in the month of November, 1910. The total importations of iron ore for 11 months of the year ended with November were 1,662,830 gross tons against 2,417,321 tons in the corresponding period of 1910. Of the November imports of iron ore 81,315 gross tons came from Cuba, 18,871 tons from Sweden, 12,300 tons from Newfoundland, 10,200 tons from Canada, 5279 tons from Spain and 54 tons from other countries.

The total value of the exports of iron and steel and manufactures thereof, not including iron ore, for 11 months of the year ended with November, was $227,469,893 against $182,971,193 in the corresponding period of 1910. The total value of the imports of iron and steel and manufactures thereof, exclusive of ore, for 11 months of the year ended with November was $26,690,333 against $36,267,671 in the similar period of 1910.

Iron and Steel Prices for Fourteen Years

Monthly Averages Computed from the Weekly Market Quotations of "The Iron Age" in the Period 1898-1911

(With Supplement.)

Accompanying this issue of *The Iron Age* is our annual chart, in which lines are plotted to indicate the course of prices for pig iron, Bessemer steel billets and some leading forms of finished iron and steel in the 14 years ending with 1911. The diagrams are based on monthly averages of prices given week by week in our market reports from the leading selling centers. The table below, which gives the monthly average prices on which the chart is based, includes also the price of No. 2 X foundry pig iron at Philadelphia, not plotted.

Bessemer Pig Iron at Pittsburgh, per Gross Ton (2240 lb.).

	1898.	1899.	1900.	1901.	1902.	1903.	1904.	1905.	1906.	1907.	1908.	1909.	1910.	1911.
January	$9.87	$10.87	$24.99	$13.15	$16.70	$22.15	$13.91	$16.85	$18.35	$23.15	$19.00	$17.34	$19.90	$15.90
February	10.05	11.60	24.80	14.43	16.93	21.45	13.66	16.41	18.35	22.85	17.90	16.78	19.34	15.90
March	10.39	14.59	24.72	16.31	17.37	21.85	14.25	16.35	18.28	22.85	17.86	16.25	18.60	15.90
April	10.41	15.03	24.70	16,75	18.75	21.28	14.18	16.35	18.19	23.35	17.49	15.78	18.27	15.90
May	10.30	16.20	21.00	16.30	20.75	20.01	13.60	16.16	18.10	24.01	16.93	15.84	17.52	15.90
June	10.34	18.51	19.72	16.00	21.56	19.72	12.81	16.65	18.23	24.27	16.90	16.05	16.60	15.90
July	10.25	20.65	16.75	16.00	21.60	18.89	12.40	14.85	18.41	23.55	16.83	16.46	16.40	15.90
August	10.35	21.75	15.60	15.75	21.62	18.35	12.81	15.20	19.00	22.90	16.23	17.03	16.09	15.90
September	10.78	23.43	13.87	15.75	21.75	17.22	12.63	15.91	19.54	22.90	15.90	18.05	15.90	15.90
October	10.36	24.18	13.06	15.89	21.75	16.05	13.10	16.54	20.35	22.00	15.71	19.53	15.90	15.44
November	10.15	24.78	13.48	16.00	21.68	15.18	14.85	17.85	22.85	20.65	16.59	19.90	15.82	15.00
December	10.58	24.90	13.43	16.31	21.75	14.40	16.65	18.35	23.75	19.34	17.40	19.90	15.90	15.03

Bessemer Steel Billets at Pittsburgh, per Gross Ton.

January	14.93	16.62	34.50	19.75	27.50	29.60	23.00	22.75	26.25	29.40	28.00	25.00	27.50	23.00
February	15.06	18.00	34.87	20.31	29.37	29.87	23.00	23.50	26.50	29.50	28.00	25.00	27.50	23.00
March	15.25	24.30	33.00	22.88	31.25	30.62	23.00	24.00	26.70	29.00	28.00	23.00	27.50	23.00
April	15.06	25.37	32.00	24.00	31.50	30.25	23.00	24.00	27.00	30.12	28.00	23.00	26.75	23.00
May	14.85	26.75	28.90	24.00	32.20	30.37	23.00	23.50	26.40	30.30	28.00	23.00	26.12	22.60
June	14.65	30.10	27.25	24.38	32.37	28.87	23.00	22.00	26.63	29.62	25.75	23.00	25.30	21.00
July	14.50	33.12	21.00	24.00	31.75	27.60	23.00	22.00	27.25	30.00	25.00	23.50	25.00	21.00
August	15.85	35.40	18.20	24.20	31.06	27.00	23.00	24.00	27.80	29.25	25.00	24.13	24.62	21.00
September	16.00	38.37	16.93	24.88	29.50	27.00	20.00	25.00	28.00	29.37	25.00	25.00	24.40	20.75
October	15.56	38.75	16.50	26.70	29.70	27.00	19.50	25.62	28.00	28.20	25.00	26.25	23.75	20.00
November	15.06	36.50	18.95	27.00	28.50	24.00	20.25	26.00	28.88	28.00	25.00	27.13	23.30	19.50
December	15.80	33.75	19.75	27.50	29.12	23.00	21.20	26.00	29.50	28.00	25.00	27.50	23.00	19.25

Basic Pig Iron, f.o.b., Mahoning or Shenango Valley Furnace, per Gross Ton.

January	....	....	....	....	....	....	....	15.46	17.06	21.90	16.90	15.50	16.87	13.25
February	....	....	....	....	....	....	....	15.25	16.82	22.00	15.97	15.12	16.31	13.65
March	....	....	....	....	....	....	....	15.55	16.85	21.50	15.62	14.94	16.00	13.75
April	....	....	....	....	....	....	....	15.06	16.88	21.50	15.25	14.05	15.94	13.75
May	....	....	....	....	....	....	....	15.06	17.00	22.90	14.91	14.12	15.19	13.32
June	....	....	....	....	....	....	11.76	14.60	16.94	22.40	15.25	14.62	14.70	13.05
July	....	....	....	....	....	....	11.20	14.00	17.12	21.75	14.51	15.05	14.50	13.12
August	....	....	....	....	....	....	11.69	14.32	17.70	21.25	14.69	15.25	14.12	13.00
September	....	....	....	....	....	....	11.60	14.86	18.44	20.06	14.43	15.90	13.70	12.80
October	....	....	....	....	....	....	12.19	15.25	19.55	19.50	14.04	16.94	13.15	12.52
November	....	....	....	....	....	....	14.00	16.87	21.37	18.12	14.72	17.25	13.25	12.42
December	....	....	....	....	....	....	15.70	16.75	21.50	17.50	15.60	17.05	13.40	....

Southern No. 2 Foundry Pig Iron at Cincinnati, per Gross Ton.

January	9.50	10.31	20.69	13.45	14.55	21.65	12.37	16.25	16.75	26.00	16.15	16.25	17.25	14.25
February	9.25	11.69	20.50	13.12	14.75	21.50	12.12	16.25	16.75	26.00	15.75	16.13	17.06	14.25
March	9.25	13.75	20.30	14.00	14.75	21.37	12.10	16.25	16.65	26.00	15.50	15.05	16.30	14.25
April	9.25	14.50	20.19	14.50	16.87	20.15	12.50	16.25	16.63	25.06	15.20	14.25	15.37	14.25
May	9.37	14.56	19.75	13.85	18.35	18.87	12.25	15.81	16.75	24.25	14.75	14.50	15.00	13.95
June	9.30	16.00	18.75	13.37	20.19	17.75	11.80	14.65	16.44	24.10	15.25	14.70	14.85	13.44
July	9.25	17.56	16.81	13.00	20.75	16.15	11.81	13.94	16.06	23.85	15.00	15.75	14.75	13.25
August	9.37	18.35	14.25	13.00	23.06	15.19	12.00	14.40	17.30	23.00	15.25	16.38	14.31	13.45
September	9.55	19.94	13.62	13.06	25.00	14.75	12.00	14.37	18.69	21.50	15.65	17.35	14.25	13.31
October	9.75	20.75	12.87	13.75	25.65	13.50	12.81	15.31	20.00	20.95	15.75	17.88	14.25	13.25
November	9.75	20.75	12.95	14.00	23.62	12.00	15.19	16.60	23.38	19.50	16.00	17.75	14.25	13.20
December	9.90	20.75	13.75	14.25	22.44	12.05	15.85	16.75	25.00	17.00	16.25	17.45	14.25	13.19

Local No. 2 Foundry Pig Iron at Chicago (at Furnace), per Gross Ton.

January	11.35	11.47	23.85	15.10	16.25	23.45	14.47	17.85	19.60	25.85	18.45	17.35	19.00	15.50
February	11.28	12.47	23.85	14.60	16.85	23.35	13.91	17.85	19.41	25.85	18.16	16.75	19.00	15.50
March	11.10	14.95	23.85	15.60	18.51	23.22	14.05	17.80	19.35	26.10	17.85	16.50	18.30	15.50
April	11.26	15.47	23.72	15.85	18.97	22.87	14.35	17.60	19.10	26.35	17.73	16.50	17.50	15.00
May	11.35	15.72	22.65	15.85	20.85	20.72	13.85	17.60	18.90	26.85	17.63	16.50	17.06	15.00
June	11.35	17.95	20.72	15.35	21.85	19.85	13.70	17.00	18.54	26.60	17.73	16.50	16.75	15.00
July	11.35	19.22	18.60	15.35	21.60	18.25	13.60	16.47	18.60	25.55	17.55	17.00	16.56	14.87
August	11.35	20.65	16.25	15.35	22.10	17.22	13.60	16.60	19.45	24.85	17.35	17.13	16.50	14.50
September	11.35	22.22	15.35	15.35	23.35	16.41	13.85	16.60	20.16	24.10	17.05	18.70	16.40	14.50
October	11.35	23.35	14.85	15.10	23.35	15.70	14.10	17.66	21.48	22.45	16.85	19.00	16.06	14.46
November	11.35	23.45	14.85	15.23	23.35	15.10	15.98	19.15	24.70	20.66	17.10	19.00	16.00	14.09
December	11.35	23.85	15.10	15.85	23.35	14.81	16.95	19.60	25.85	18.80	17.35	19.00	16.00	14.00

Standard Brands Eastern Pennsylvania No. 2 X Foundry Pig Iron at Philadelphia, per Gross Ton.

January	10.87	11.44	22.70	15.50	16.75	22.45	14.69	17.50	18.50	24.80	18.25	17.25	19.00	15.50
February	10.75	11.06	22.56	15.31	17.19	22.25	14.50	17.50	18.50	25.87	18.25	17.00	18.69	15.50
March	10.55	14.70	22.31	15.12	18.81	22.25	14.80	17.56	18.35	25.00	18.12	16.37	18.00	15.50
April	10.50	15.75	21.75	15.46	19.62	21.87	15.00	17.75	18.44	24.81	17.65	16.20	17.75	15.50
May	10.50	15.81	20.60	15.19	19.75	20.06	14.75	17.81	18.50	25.55	16.94	16.06	17.00	15.50
June	10.50	17.25	18.75	15.06	20.94	19.19	14.50	16.75	18.44	24.62	16.62	16.42	16.55	15.25
July	10.00	19.44	16.37	15.00	22.30	18.10	14.31	16.12	18.25	23.06	16.50	16.50	16.25	15.00
August	10.30	20.65	16.15	14.97	22.00	16.87	14.25	16.25	19.00	21.90	16.50	17.00	16.00	15.00
September	10.75	22.75	15.56	14.80	22.00	16.12	14.25	16.43	20.44	20.50	16.62	18.05	16.00	15.00
October	10.75	22.75	15.00	15.25	22.12	15.20	14.43	17.25	21.12	19.85	16.75	18.69	15.81	15.00
November	10.87	23.40	15.35	15.37	23.37	15.00	15.75	18.05	23.30	18.94	17.00	19.00	15.68	14.95
December	11.06	23.25	15.62	15.75	23.00	15.00	16.90	18.25	24.00	18.84	17.25	19.00	15.50	14.85

Soft Steel Bars at Pittsburgh, in Cents per Pound.

January	0.98¾	1.02½	2.22½	1.25	1.50	1.60	1.30	1.40	1.50	1.60	1.60	1.40	1.50	1.40
February	0.95	1.12½	2.21¼	1.30	1.51¼	1.60	1.30	1.40	1.50	1.60	1.60	1.35	1.50	1.40
March	0.93½	1.36	2.25	1.40	1.60	1.60	1.33	1.50	1.50	1.60	1.60	1.20	1.45	1.40
April	0.95	1.56¼	2.10	1.47½	1.60	1.60	1.35	1.50	1.50	1.60	1.60	1.15	1.45	1.40
May	0.92½	1.67½	1.91	1.41	1.60	1.60	1.35	1.50	1.50	1.60	1.60	1.18¾	1.45	1.37
June	0.90	1.98	1.52½	1.40	1.60	1.60	1.35	1.46	1.50	1.60	1.45	1.20	1.45	1.25
July	0.91¼	2.02½	1.18¾	1.40	1.60	1.60	1.35	1.50	1.50	1.60	1.40	1.27	1.45	1.23½
August	0.93¾	2.14	1.05	1.44	1.60	1.60	1.35	1.50	1.50	1.60	1.40	1.32½	1.40	1.20
September	1.02	2.40	1.12½	1.50	1.60	1.60	1.31	1.50	1.50	1.60	1.40	1.39	1.40	1.18¾
October	0.97	2.38¾	1.08¾	1.53	1.60	1.60	1.30	1.50	1.50	1.60	1.40	1.51¼	1.40	1.12½
November	0.94	2.24	1.18	1.50	1.60	1.37½	1.31¼	1.50	1.54	1.60	1.40	1.50	1.40	1.08
December	0.95	2.20	1.25	1.50	1.60	1.30	1.34	1.50	1.60	1.60	1.40	1.50	1.40	1.12½

Years

n our market
e table below,
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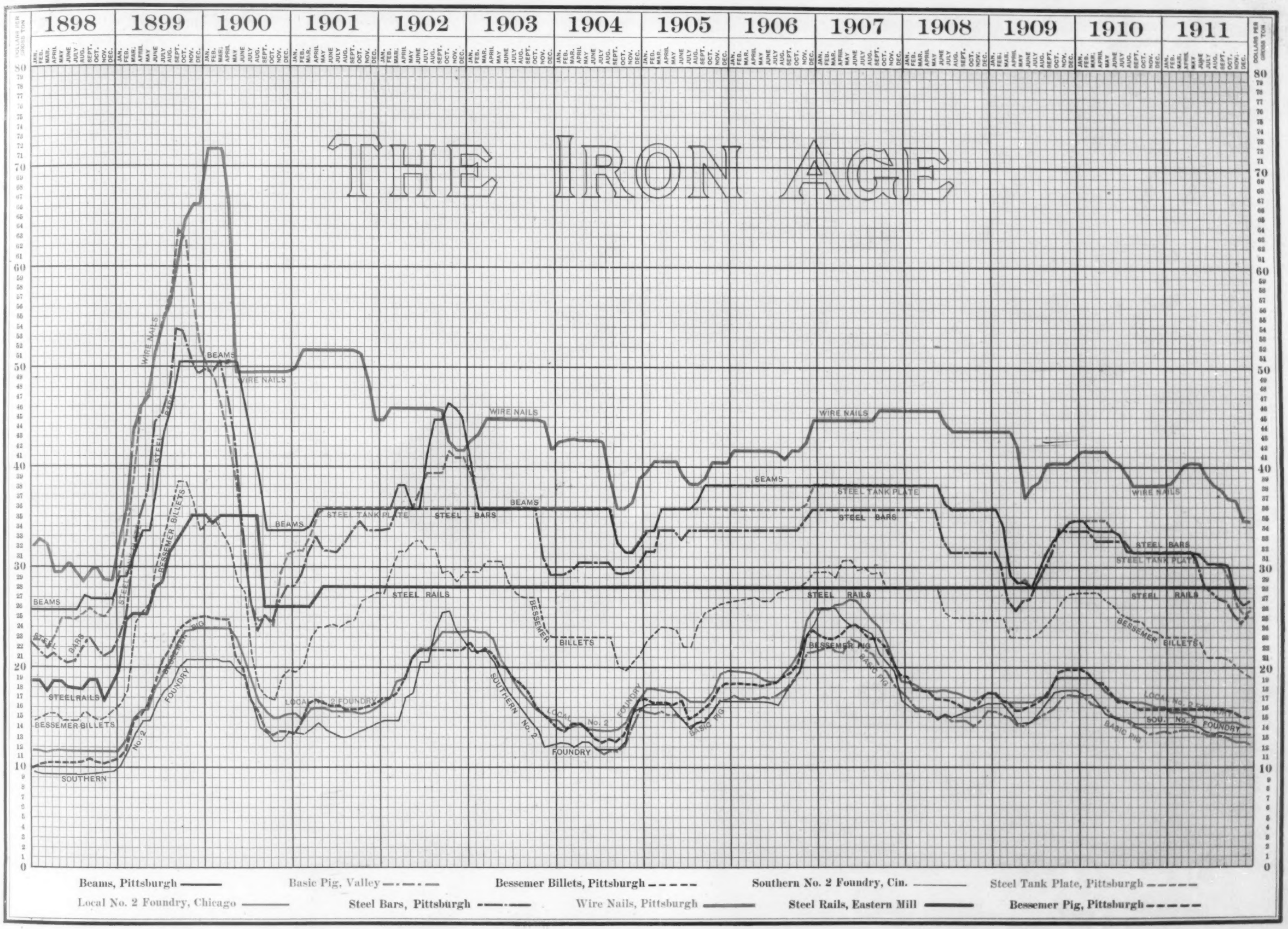
foundry pig

1910.	1911.
19.50	$15.90
19.34	15.90
18.60	15.90
18.27	15.90
18.35	15.90
18.60	15.90
18.40	15.90
18.00	15.90
18.00	15.90
18.00	15.44
18.02	15.00
18.80	15.03
24.50	23.00
24.50	23.00
24.50	23.00
24.25	23.00
24.12	22.60
24.50	21.00
24.50	21.00
24.62	21.00
24.62	20.75
24.25	20.00
24.50	19.50
24.00	19.25
18.87	13.25
18.81	13.65
18.63	13.75
18.44	13.75
18.19	13.32
18.00	13.05
18.06	13.12
18.25	13.00
18.19	12.80
18.25	12.82
18.25	12.42
18.25	....
18.25	14.25
18.25	14.25
18.25	14.25
18.25	14.25
18.25	13.95
18.25	13.44
18.25	13.25
18.25	13.45
18.25	13.41
18.25	13.28
18.25	13.20
18.25	13.19
18.25	15.50
18.25	15.50
18.25	15.50
18.25	15.00
18.25	15.00
18.25	15.00
18.25	14.87
18.25	14.50
18.25	14.50
18.25	14.45
18.25	14.09
18.25	14.00
18.25	15.50
18.25	15.50
18.25	15.50
18.25	15.50
18.25	15.50
18.25	15.25
18.25	15.00
18.25	15.00
18.25	15.00
18.25	14.95
18.25	14.85
18.25	1.40
18.25	1.40
18.25	1.40
18.25	1.40
18.25	1.37
18.25	1.25
18.25	1.23½
18.25	1.20
18.25	1.18½
18.25	1.12½
18.25	1.08
18.25	1.12½



Fluctuations in the Prices of Crude and Finished Iron and Steel from January 1, 1898, to January 1, 1912—Gross Tons.

Tank Plates at Pittsburgh, in Cents per Pound.

	1898.	1899.	1900.	1901.	1902.	1903.	1904.	1905.	1906.	1907.	1908.	1909.	1910.	1911.
January	1.00	1.30	2.22½	1.40	1.60	1.75	1.60	1.50	1.60	1.70	1.70	1.60	1.55	1.40
February	1.00	1.47½	2.17½	1.40	1.60	1.60	1.60	1.50	1.60	1.70	1.70	1.52½	1.55	1.40
March	0.97½	1.75	2.03	1.47½	1.60	1.60	1.60	1.60	1.60	1.70	1.70	1.30	1.55	1.40
April	1.02½	2.05	1.87½	1.57½	1.60	1.60	1.60	1.60	1.60	1.70	1.70	1.27½	1.55	1.40
May	1.10	2.12½	1.69	1.60	1.60	1.60	1.60	1.60	1.60	1.70	1.70	1.28¾	1.51¼	1.39
June	1.10	2.32	1.38¾	1.60	1.68¾	1.60	1.60	1.60	1.60	1.70	1.62½	1.25	1.48	1.35
July	1.08¾	2.45	1.16¼	1.60	1.75	1.60	1.60	1.60	1.60	1.70	1.60	1.33	1.41¼	1.35
August	1.11⅞	2.55	1.09	1.60	1.75	1.60	1.60	1.60	1.60	1.70	1.60	1.40	1.40	1.34
September	1.15	2.85	1.11¼	1.60	1.75	1.60	1.44	1.60	1.60	1.70	1.60	1.46	1.40	1.28¾
October	1.12½	2.78¾	1.07½	1.60	1.84	1.60	1.40	1.60	1.60	1.70	1.60	1.50	1.40	1.17½
November	1.11½	2.52	1.31	1.60	1.82½	1.60	1.40	1.60	1.62½	1.70	1.60	1.53¾	1.40	1.13
December	1.16	2.30	1.38¾	1.60	1.82½	1.60	1.45	1.60	1.70	1.70	1.60	1.55	1.40	1.15

Beams at Pittsburgh, in Cents per Pound.

January	1.15	1.30	2.25	1.50	1.60	1.80	1.60	1.50	1.70	1.70	1.70	1.60	1.55	1.40
February	1.15	1.30	2.25	1.50	1.60	1.60	1.60	1.50	1.70	1.70	1.70	1.52½	1.51¼	1.40
March	1.15	1.40	2.25	1.52½	1.70	1.60	1.60	1.60	170	1.70	1.70	1.30	1.50	1.40
April	1.15	1.50	2.25	1.60	1.70	1.60	1.60	1.60	1.70	1.70	1.70	1.27½	1.50	1.40
May	1.15	1.50	2.25	1.60	1.60	1.60	1.60	1.60	1.70	1.70	1.70	1.27½	1.50	1.39
June	1.15	1.70	2.07½	1.60	1.60	1.60	1.60	1.60	1.70	1.70	1.62½	1.25	1.48	1.35
July	1.15	1.93¾	1.90	1.60	1.84	1.60	1.60	1.60	1.70	1.70	1.60	1.33	1.41¼	1.35
August	1.21¼	2.05	1.74	1.60	2.00	1.60	1.60	1.63	1.70	1.70	1.60	1.40	1.40	1.35
September	1.20	2.25	1.50	1.60	2.00	1.60	1.44	1.70	1.70	1.70	1.60	1.46	1.40	1.33¾
October	1.20	2.25	1.50	1.60	2.07	1.60	1.40	1.70	1.70	1.70	1.60	1.50	1.40	1.21¼
November	1.20	2.25	1.50	1.60	2.05	1.60	1.40	1.70	1.70	1.70	1.60	1.53¾	1.40	1.13
December	1.20	2.25	1.50	1.60	2.00	1.60	1.44	1.70	1.70	1.70	1.60	1.55	1.40	1.15

Wire Nails at Pittsburgh, per Keg of 100 lb.

January	$1.42	$1.43	$3.20	$2.22	$1.99	$1.89	$1.89	$1.75	$1.85	$2.00	$2.05	$1.95	$1.85	$1.71¼
February	1.45	1.57	3.20	2.30	2.05	1.92	1.90	1.80	1.85	2.00	2.05	1.95	1.85	1.75
March	1.43	1.94	3.20	2.30	2.05	2.00	1.91	1.80	1.85	2.00	2.05	1.95	1.85	1.79
April	1.31	2.05	2.95	2.30	2.05	2.00	1.90	1.80	1.85	2.00	2.05	1,87	1.85	1.80
May	1.31	2.10	2.20	2.30	2.05	2.00	1.90	1.80	1.85	2.00	2.05	1.65	1.82	1.80
June	1.35	2.30	2.20	2.30	2.05	2.00	1.90	1.74	1.85	2.00	1.97	1.70	1.80	1.75
July	1.31	2.42	2.20	2.30	2.05	2.00	1.89	1.70	1.84	2.00	1.95	1.72	1.75	1.70
August	1.26	2.50	2.20	2.30	2.05	2.00	1.71	1.70	1.82	2.00	1.95	1.80	1.70	1.69
September	1.32	2.76	2.20	2.30	2.03	2.00	1.60	1.74	1.86	2.05	1.95	1.80	1.70	1.65
October	1.33	2.87	2.20	2.28	1.89	2.00	1.60	1.80	1.85	2.05	1.95	1.80	1.70	1.63¾
November	1.28	2.95	2.20	2.17	1.85	1.97	1.62	1.80	1.88	2.05	1.95	1.80	1.70	1.55
December	1.27	2.95	2.20	1.99	1.85	1.87	1.73	1.80	2.00	2.05	1.95	1.85	1.70	1.53¼

In plotting the lines, those representing finished material have been derived by multiplying the market prices of finished material per pound by 2240, so that the traversing lines would show the exact price relation between gross tons of all products. In the table above, however, while pig iron and steel billet prices are in dollars per gross ton, those for finished material are stated in the usual way—namely, in cents per pound.

The prices used in plotting the curves are in all cases those for early delivery. The 14 years are a most interesting period in the iron trade of the country, beginning with 1898, the year in which the depression following the panic of 1893 produced its culminating effect upon iron and steel prices. The rapid advances of 1899 give a remarkable peak, which is the spectacular feature of the chart. Almost equally noteworthy are the declines of 1900. In 1901 prices were fairly steady, with advances in the latter part of the year, bringing another series of high points in 1902, though these are moderate in comparison with 1899. The sharp decline of 1903 is distinctly shown; the slight further decline extending over nine months of 1904, with advances in the latter part of the year; some reaction in 1905, followed by advances in the latter part of the year and a comparatively stable level for the first half of 1906. Then came a strong movement upward, carrying prices to substantially the levels of 1902, followed by recessions after the middle of 1907. The price maintenance movement modified the decline in the depression of 1908, and in the spring of 1909 came some abrupt declines, which stimulated buying and gave the strong upward curve of the second half of 1909. In general, 1910 was a year in which the price movement reversed that of 1909, pig iron reaching again its low points of 1909, while finished materials only retraced part of the distance to the bottom touched after the open market declaration of February, 1909. Steadily declining prices marked 1911, the downward movement being unchecked until the very last month of the year, when a slight upward turn occurred.

Railroad Presidents on the Outlook

In its issue of December 29 the Railroad Age Gazette, New York, gives expressions from a number of presidents and other executive officers of railroads concerning prospects for railroad buying, the outlook for business in 1912 and the present status of the agitation for railroad regulation. The presidents generally are of the opinion that their business and all business will be better in 1912 than in 1911, and that railroad expenditures for equipment will be greater next year. However, they do not venture on enthusiastic expressions concerning the prospect. One president says that while the railroads are apt to spend a little more money on maintenance, improvements and new equipment in 1912 he is doubtful about new construction. The incentive for capital to go into new railroad enterprises is lacking, he says. Another president considers that larger outlays by the railroads this year will depend on whether a better market develops for railroad securities. Some of the opinions are rather non-committal and the effect of political activities in 1912 is referred to as something to be reckoned with. Little is said concerning an advance in freight rates, and one of the presidents speaks of the shipper as unchanged in his determination not to permit advances.

After being idle for many months, Rosena furnace of the Carnegie Steel Company was put in blast last week, and the entire New Castle, Pa., group is now active.

To Regulate the Handling of Explosives

The National Metal Trades Association has had drawn up a bill to regulate the manufacture, sale and use of explosives. It provides that a person or firm manufacturing, handling, storing or selling high explosives shall be required to file with the county clerk an application for a license. It must be accompanied by a sworn statement giving the location and description of the factory or building, its proximity to houses and railroads, and the kind and quantity of goods to be manufactured or stored. The buildings are to be examined. The cost of a license is $25 per year. The bill further provides that any person having on hand 100 lb. or more of explosives at any time shall furnish a bond to provide for the payment of damages that might arise from explosion. When such explosives are sold or given away a signed statement must be procured from the person to whom they are delivered; it shall give the name, address, date of sale and use to which the explosives are to be put. The penalty for violation of the act is a fine of from $100 to $500 or imprisonment from one to 10 years.

The Monongahela Tube Company, Pittsburgh, Pa., calls attention to the fact that its name appeared in the wrong list in the article headed "The Wrought Pipe Industry," which appeared in *The Iron Age* of December 21. This company does not make and never has made a single foot of steel pipe but only makes wrought iron merchant pipe. In boiler tubes it makes both soft steel and charcoal iron.

Refrigeration Plant for Dry Air Blast

A Description of Later Methods of Applying the Two-Stage System Which Are More Economical in Construction and Operation

BY JAMES GAYLEY

In the first method of installing dry air plants, the moisture was extracted by passing the air over coils of pipe, which were cooled to a low temperature by the circulation of brine; and while this method has proved effective in practice, cheaper methods have since been worked out.

On the principle that it is easier to go from one temperature to another by a succession of steps, rather than by a single step, several methods of applying the two-stage system have been evolved, which, while producing the same results, are more economically operated and can be installed much more cheaply. By the use of the accompanying illustrations, I will briefly describe various types of refrigerating chambers.

Fig. 1 shows a two-stage refrigerating chamber, which represents cooling by a combination of direct and indirect contact. One chamber is filled with screens and the other with coils of pipe. These screens may be made of expanded metal lathing, separated by baffle strips, causing the air to pursue a tortuous course. The air passing up through the screens is met with a descending shower of water, which is cooled as closely as practicable to the freezing point. This removes about two-thirds of the moisture. The air then passes up through moisture eliminators, in which any entrained moisture is removed, and afterward passes downwardly over the refrigerating coils. A small stream of brine is allowed to flow over the coils, and this film of brine prevents the formation of frost. Consequently the operation of the chamber becomes a continuous one, and the work done in the coil chamber is practically constant, as the air leaves the first chamber at the same temperature.

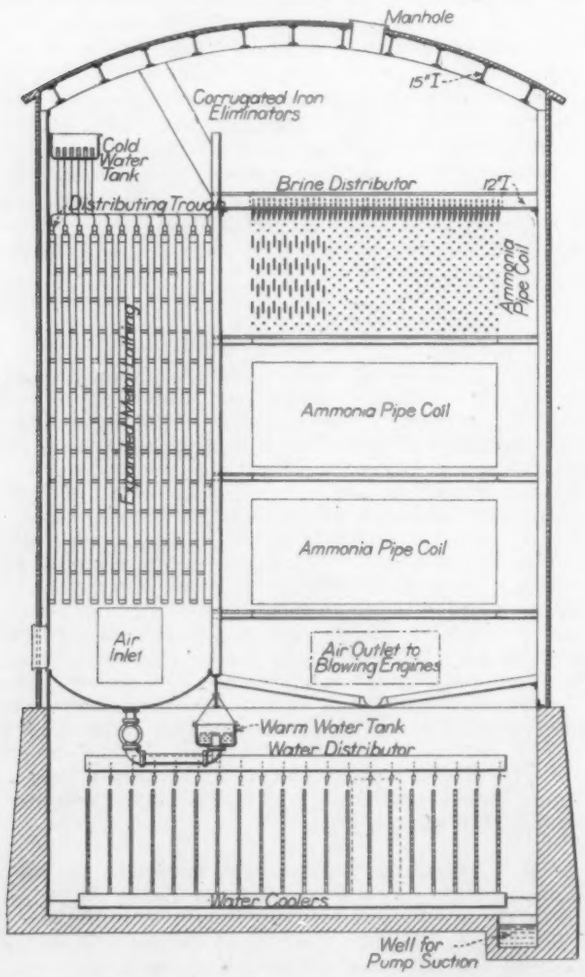
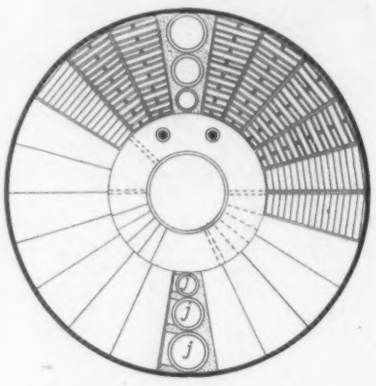


Fig. 1—Two-Stage Refrigerating Chamber. Cooling by Direct and Indirect Contact



Section X-X

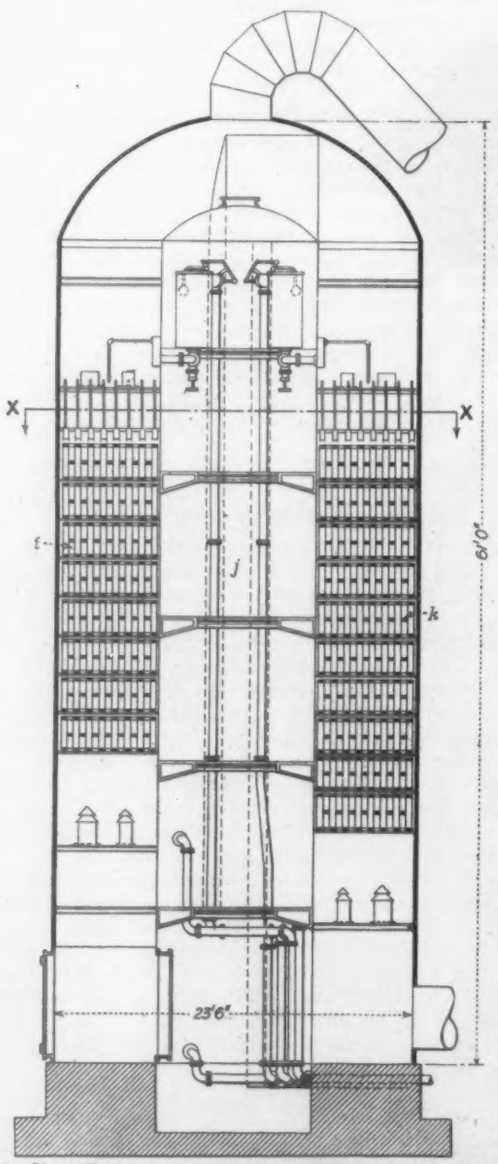


Fig. 3—Short Tower Type, with Direct Contact of Air with Water and Brine. A Modification of the Design in Fig. 2

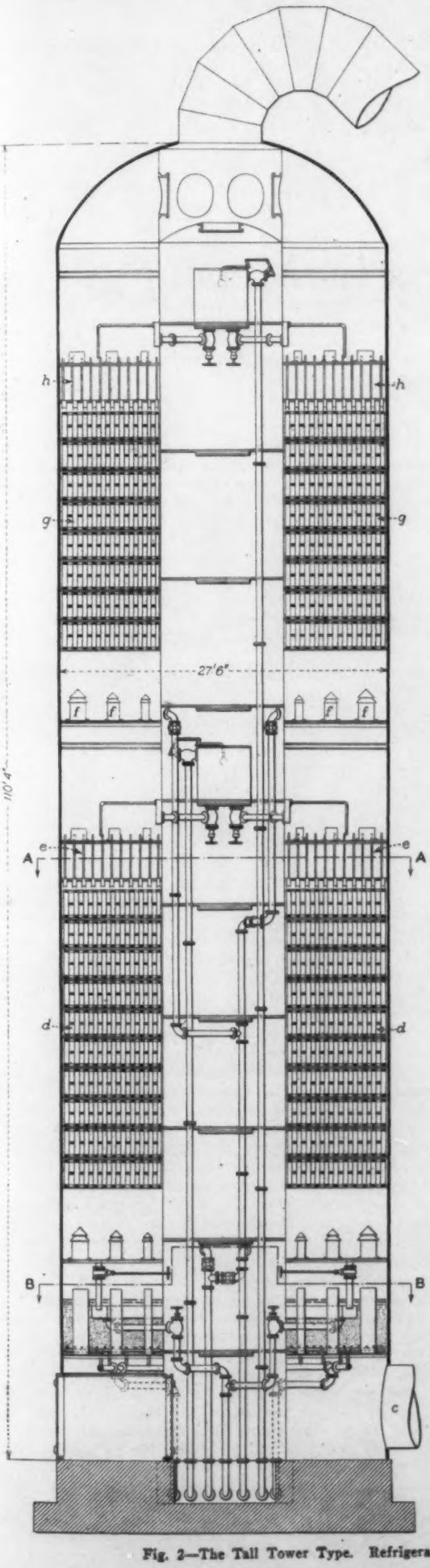


Fig. 2—The Tall Tower Type. Refrigeration Entirely by Direct Contact

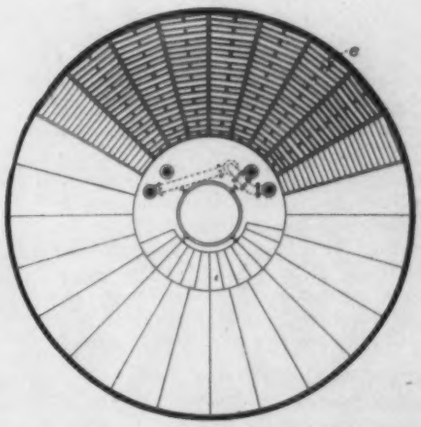
The cooling water with that from condensation collects in the cooling chamber underneath, where it is kept at a practically constant temperature, and the surplus accumulated by the condensation of the atmospheric moisture can be used for other condensing purposes.

Fig. 2 represents the tall tower type, designed by Bruce Walter, of Pittsburgh, to conduct the refrigeration by direct contact entirely. This has capacity for a furnace requiring 40,000 cu. ft. per min., while Fig. 3 is for a furnace requiring 25,000 cu. ft. per min. The variation in design is made to meet any limitation of ground space that would be likely to present itself at any furnace plant, and requiring no more than a hot blast stove.

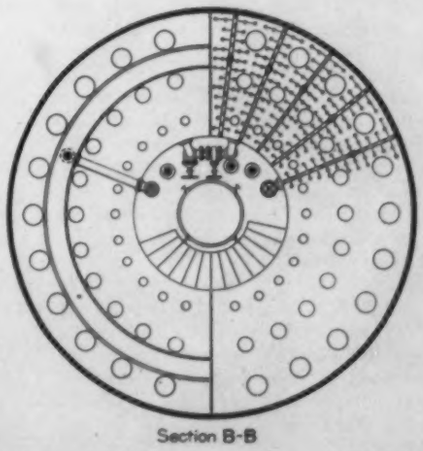
In Fig. 2 the air enters at *c* and passes up through pipes to the chamber *d*, which is filled with screens or grids, over which flows a constant stream of cold water. The air is thus brought into intimate contact with the water and the greater part of its moisture is condensed and removed. Next the air passes through the moisture eliminators *e*, then through the outlet pipes *f* to the brine chamber *g*. In this chamber the air comes in direct contact with brine cooled to a very low temperature, and the moisture is reduced to 1 grain per cu. ft.

The air comes to the brine chamber with a practically constant amount of moisture, and by further cooling additional moisture is condensed and the brine strength is gradually weakened. The revivifying of the brine is not a difficult or expensive matter, for there is plenty of waste heat at the furnace that can be used for this purpose, and a simple apparatus has been devised by Mr. Walter to maintain the strength of the brine, which operates automatically. The center of the tower can be used for a stairway or elevator for use of the workmen, but there is, in the nature of the operation, little to get out of order. The whole method of operation is simple and effective. The tower is built of steel plates, and the cooling fluids come in contact with metal surfaces only, as the insulation is on the outside of the tower.

The work that the fan has to do is that required to lift the air the distance from the fan discharge to the inlet of the blowing engines. The cost of installation by this method, as worked out by several engineers, is about one-half the cost necessary to install under the earlier coil-pipe system, where the moisture was deposited as snow. So the return on the investment is nearly doubled.



Section A-A



Section B-B

Fig. 3 represents a shorter tower type, designed for a medium type of furnace. This likewise operates on the direct-contact system with water and brine. The air first passes up through the water spray chamber *i*, then down through the conduits *j*, and upwardly through the brine spray chamber *k*. The space around the conduits is filled with insulating material, as the chambers on either side have different temperature conditions.

In the direct-contact system provision is made

for discontinuing the use of the water spray chambers when the natural air temperature, as in the winter season, does not require its use.

In installing the dry-air process, a surplus of refrigerating power above the average requirements is made necessary, to meet the conditions of the high humidity of the summer season, and this provides during the greater part of the year a material surplus of refrigerating capacity, which can be used in other directions. This has been done successfully on a small scale at the South Chicago works of the Illinois Steel Company, in the making of ice for use around the works. There is no reason why this cannot be carried out on a much larger scale, and not only offset the cost of operating the dry-air plant, but also show an additional profit per ton of pig iron.

At nearly all seasons of the year the humidity is less at night than during the day, and the night surplus of refrigerating power could be used for this purpose. Making of artificial ice can readily be made a by-product of the dry-air process in nearly every locality, and by-products are profitable.

There is an abundant supply of condensed steam at all iron works, which could be turned into ice of unquestioned purity.

The World's Progress in Metallurgy

Ancient Iron and Steel—Unsolved Problems—Alloy Steels—Tensile Strength and Temperature

BY SIR ROBERT A. HADFIELD

Introduction

You have been good enough to ask me to contribute a few remarks to your January 4 issue. I greatly appreciate your invitation and shall be very glad if some of the facts I have the pleasure of presenting prove of interest to your readers.

First let me say how much indebted I have always been to your valuable journal. It is the leading source of technical information on iron and steel in the New World, and is often most useful to many of us in the Old World. Your enterprise for many years in presenting excellent translations of papers from abroad has been of the greatest value to metallurgists; I personally can testify to its great value, and have benefited from your labors in this direction. Our confrères in France, Germany, Sweden, Italy, Belgium, Russia, and even Japan, as well as elsewhere, all outside the Anglo-Saxon speaking race, have had much to say and have done much to help on metallurgical knowledge during the past 30 years. Some of this work would have been unknown but for your wise policy in presenting it in English, read as it has been not only by your own countrymen but by many of us in Great Britain, Canada, and elsewhere. I take this opportunity of personally thanking you for this source of information, which has been of great service.

While the opinion, coming as it does from a metallurgist, may be a prejudiced one, it is my strong conviction that the world's great progress and prosperity during the last half century have been largely due to the enormous strides made in the science of metallurgy. The effect upon our social life and well-being has been most remarkable. A little later on I will quote a singular and very simple instance of this in connection with Faraday.

Faraday's Experiments with Alloys of Steel

I was recently reading Faraday & Stodart's paper on "Alloys of Steel," which appeared in the Philosophical Transactions of the Royal Society, Volume XII, 1822. Faraday, a true "immortal" if ever there was one, had the keen foresight to recognize that alloys of iron with other elements had a great future. My copy of this paper is very precious, for it bears the words "P. Barlow, Esq., from the author," in handwriting which I believe to be that of Faraday himself. I do not know who Mr. Barlow was, but to have an autograph of the great scientist who did so much for the world gives no little satisfaction. Somewhat singular to say, the signature of Stodart, who was also a Fellow of the Royal Society, is not at all unlike Faraday's, but on the whole I incline to the signature being that of Faraday himself.

It may be interesting to say that Stodart, the joint author of the paper referred to, signed the roll-call of Fellowship of the Royal Society in 1822, and Faraday's signature is on the page immediately opposite, two years later, that is in the year 1824. It would appear, therefore, that Stodart must have in some way been the means of proposing and supporting Faraday for admission to the Royal Society as a Fellow.

The copy of this paper, which I acquired some time ago through my book-agent, was evidently one which the author had sent to some friend. In order to see the signature of Faraday, I paid a visit to the secretary of the Royal Society a short time ago, when he kindly allowed me to inspect the roll-call book in which, as it happens, I had myself the honor of signing only a short time ago.

This roll-call, which is signed by every Fellow upon entering the society, dates back, and has been carefully preserved, for many centuries. There is not a page or I believe a single Fellow's autograph missing. On the first page is the signature of Charles the Second, and close alongside that of Prince Rupert; a little further on, that of James the Second, and so on, down to our own times with Queen Victoria's signature, that of the late lamented King Edward VII, and of our present popular King, George V. Year by year have been added, including many names from your country, the signatures of almost all those who have helped to advance knowledge and research among the Anglo-Saxon race, to say nothing of illustrious names from France, Germany, and elsewhere.

To read signatures such as those of Newton, Darwin, Davy, Faraday, Huxley, Tyndall, Kelvin, Darwin, Hooker, Lister, Huggins, Thomson, Dewar, Rayleigh, is indeed soul-stirring when it is remembered how much they have done for the world. All, too, by peaceful advance, and not by "war's rude alarm."

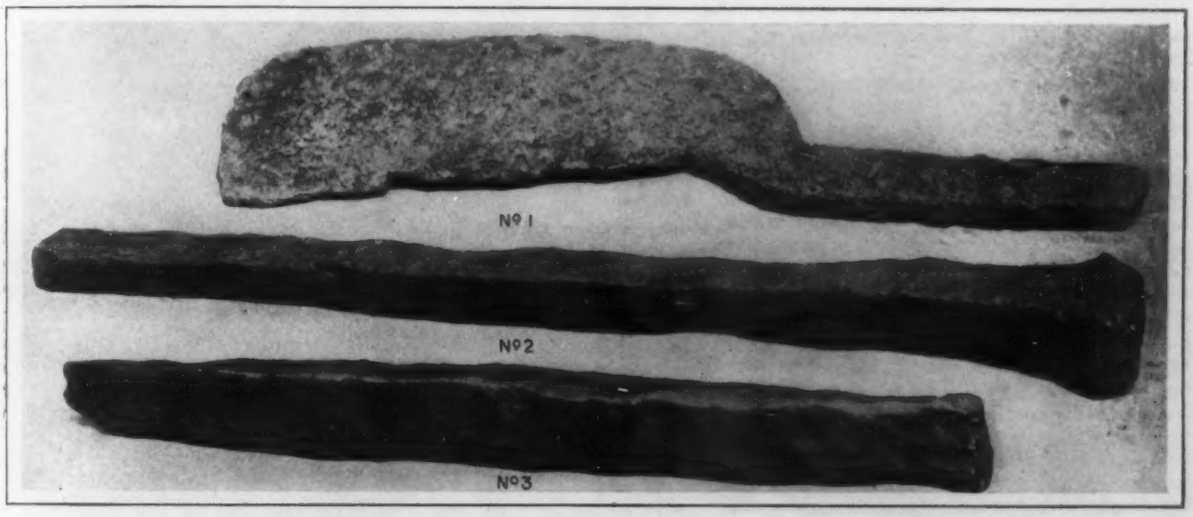
Faraday, in describing his experiments (1822), mentions that he himself could not go to Sheffield, where he intended to have his alloys made in continuance of the experiments he and Stodart had started at the Royal Institution. He added that he was "carefully preparing the mixtures to be melted in Sheffield in separate parcels, and the work was to be given to a trusty assistant, who was to go down and see the experiments put in hand and completed." Now at that time there was, of course, only one way of sending the specimens from London to Sheffield, which was by coach; there was no iron or steel highway. We can picture the great scientist carefully sorting out and packing the material in parcels. These are taken to the starting point of the coach, ready to set off on its journey north, with its prancing and well groomed horses and its rubicund driver. Notwithstanding the weather and the highwaymen, probably the coach would arrive in Sheffield a couple of days afterward. This journey of 160 miles now occupies in the fast trains of the day about 174 minutes, or by means of the automobile it is possible to do the distance in a little over six hours. But for the metallurgist, neither of these facilities would have become possible. You, too, in America, have equally benefited from the introduction of this great "iron highway" and the automobile, the final success of both of which depends upon the efforts of the metallurgist. I especially include the automobile, for take away modern special steels and it would be impossible to build a successful high speed machine.

Thus this little instance of Faraday's life brings home to us the enormous advance we have made within a century of time. The world's production of pig iron was then but a few million tons per annum.

May I point out, with reference to the enormous increase in production which has taken place, that in the curve given in my presidential address to the Iron and Steel Institute in 1905, I there expressed the opinion that the total pig-iron output, at that time about 46,000,000 tons, would in 1910 probably reach 52,500,000 tons. As a matter of fact, I was considerably under the mark, for the actual output for 1910 was 66,000,000 tons. Thus, in even the short space of five years since that address was given, the world has advanced much more rapidly than the most sanguine of us could have thought possible. Where will it stop? The curve surely cannot proportionately advance at this enormous rate.

Ancient Iron and Steel

To turn from modern production to the work of the metallurgists of many centuries ago, I may mention that I have recently been carrying out a research, which I believe will prove of importance, on some specimens of iron and steel having an age of about 1400 years. This research will be published before long by one of our scientific societies, but I may mention briefly that my conclusions show that much more knowledge of metallurgy prevailed in those earlier times than that with which we have been inclined to credit the metallurgist of former ages.



Specimens of Ancient Iron from Ceylon. No. 1 is a "Ketta" or Bill Hook. No. 2 is a Nail, 13½ in. in Length. No. 3 is a Chisel. The Nail and Chisel are from Sigiriya and Were Made in the Fifth Century, A.D.

The following is the analysis of one of these specimens, which I think is of special interest, as I am not aware that complete analysis and also determination of the physical properties, which are shown in my research, have before been obtained upon material of an antiquity definitely known and vouched for,

	C.	Si.	S.	P.	Mn.	Fe.
Per cent	traces	0.12	0.003	0.28	nil	99.3

The specific gravity of this material was 7.69. It will be seen that it is not very different from the wrought iron of today.

I further found, during a tour round the world, that in Ceylon there has for many years been practiced on a small scale the melting of bar iron and carbonizing material in clay crucibles. As this industry has probably been going on for centuries, it would appear that our Western idea that crucible steel was invented not in the East but in the West has not been altogether correct.

Unsolved Problems

In the Forrest Lecture on "Unsolved Problems in Metallurgy" I delivered a few years ago, some of the directions were pointed out in which metallurgists wanted more light. While it is remarkable how rapidly advances have been made in the last 20 years, yet in this ever-changing world, when one set of problems has apparently been solved, another set presents itself.

One of the greatest branches of study in metallurgy is that of crystallization. As pointed out in the lecture above referred to, "Iron is more sensitive, and also has the power of varying its crystallization or form of structure, probably in a greater degree than any other metal." Also that "The whole art of producing steel of high quality consists in obtaining and controlling the type of crystallization desired."

By our constantly advancing knowledge of heat treatment, and the more correct handling of the pyrometer, which mean controlling crystallization, we are today obtaining the desired quality of materials with much more uniformity and certainty. No one in America has done more than Dr. G. K. Burgess, of your Bureau of Standards at Washington, to help on this important phase of metallurgical knowledge.

There are, however, "deeper depths" where apparently even a study of crystallization does not help us. It is quite possible by immersion in liquid air to double the tenacity of pure iron, and yet so far the microscope does not help us to detect any change of structure at the lower temperature. In another case, Swedish charcoal iron having a tensile strength of 20 tons per sq. in. with 20 per cent. elongation at ordinary atmospheric temperature, ran up to 42 tons when tested at —193 deg. C. (absolute temperature 85 deg.), with an increase in Brinell ball hardness from 88 to 223, when tested as quenched in liquid air. These tests were necessarily taken upon bars of small dimensions, the diameter being ¼-in. and the effective testing length 2-in. The analysis of the Swedish charcoal iron used was as follows:

	C.	Si.	S.	P.	Mn.	Fe.
Per cent	0.045	0.07	0.005	0.004	trace	99.82

The following were the results of the tests:

Temperature	Tensile strength, tons per sq. in.
+ 18° C.	20
— 80° C.	27
—100° C.	30
—193° C.	42

It may be mentioned that metallic nickel with a tensile strength of 29 tons per sq. in. was increased to 46 tons per sq. in. when immersed in liquid air, the elongation rising from 43 to 51 per cent.

"Crystalline rigidity" of the material would perhaps be an expressive term to explain these extraordinary results. A satisfactory explanation of the facts noticed still, however, remains to be found; in other words, this particular problem is still unsolved.

Dr. J. O. Arnold, in commenting upon my paper on "Experiments Relating to the Effect on Mechanical and Other Properties of Iron and its Alloys Produced by Liquid Air Temperatures," said that "Diagram No. 36 conclusively proved the newly discovered properties of iron to be in no way due to allotropic change, as the curve from absolute temperature to absolute zero was smooth and possibly parabolic, the co-ordinates of this curve being maximum stress and breaking temperature."

As will be seen from this diagram, given herewith,

at absolute zero the estimated tenacity of pure iron would be about 70 tons. In other words, pure iron at such temperature would have the tensile strength of hard carbon steel, which is very remarkable.

Sensitiveness of Iron to Temperature Changes

The facts I have referred to show the sensitiveness of iron to changes of temperature "downward." As regards its equal sensitiveness to changes "upward," that is in the form known as "carbon steel," the fact pointed out by S. N. Brayshaw in some excellent research work he has done may be mentioned, namely, that at certain critical temperatures a difference of even one deg. Centigrade will considerably modify the physical qualities; he has given good evidence of this in his work. Moreover, we know that ordinary carbon steel of tool steel grade quenched at 725 deg. C. will bend considerably and have a Brinell hardness number of 228. Quenched at 735 deg. C. the same material will only bend 1.5 deg., the hardness number being increased to 512. Quenched at 740 deg., or only 5 deg. higher, the bend is nil and the hardness number is increased to the high figure of 713.

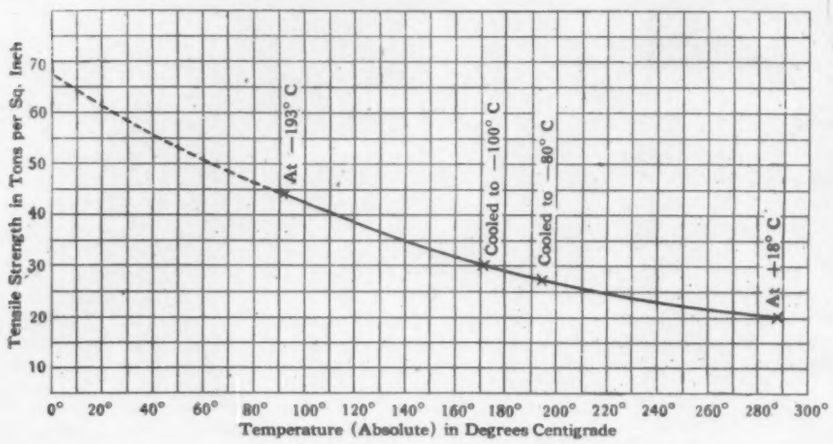


Diagram Showing the Tenacity of Iron at Diminishing Temperatures

Thus we have the remarkable fact that by increasing the temperature only 15 deg. C. we beg the phenomenon of complete hardening. The small difference of 15 deg. C. (27 deg. F.), within which range hardening or non-hardening results occur, represents no more than the change in temperature between a spring and a summer day in my country, yet such slight differences in temperature entirely revolutionize the structure of steel.

While I have quoted the Brinell hardness factor, it should be mentioned that great credit is due to the ingenious American engineer, A. F. Shore, for the very useful apparatus, the scleroscope, which he has put at the disposal of the metallurgist for defining and measuring hardness.

Alloy Steels

While for the past two or three years there may not have been any developments or novelty in alloy steels, attention may be called to some remarkable facts relative to the tenacity of iron, also iron and its alloys.

This subject of alloys of iron with other elements is one of fascinating interest. My paper on "Manganese Steel," the result of labors extending over the whole of the decade 1880-1890, was probably the first systematic research and examination of iron alloys carried out in an entirely new field, that is, to make and completely investigate the effect of an added element other than carbon upon the important metal iron. This research gave a complete correlation of the qualities of the alloy, whether as regards method of manufacture, also chemical, physical, mechanical, electrical and other qualities.

From the decade 1880-1890 onward I presented before various technical societies, 35 papers bearing on this and kindred subjects, together with oral and written discussions, in themselves equivalent to a considerable number of papers. This indicates the large amount of work I have carried out.

As regards the paper I read before the Iron and Steel Institute in 1905 on "Experiments Relating to the Effect on Mechanical and Other Properties of Iron and its Alloys Produced by Liquid Air Temperatures," this research represented about 500 mechanical tests and 500 electrical tests, and nearly 1000 separate analyses were made; in fact, the paper as a whole represents at least 2000 observations, duly set forth and classified.

Referring now to the somewhat new points which I wish to bring before your readers, probably it will be admitted that for a long time it has been thought that the tenacity of steel in any ordinary form, such as bars and other similar shapes, could not exceed about 100 tons per sq. in. Even this high tenacity has been a somewhat *rara avis* and has only been produced artificially, so to speak, by great care in heat treatment, quenching in oil or water baths, etc.

It is stated that piano wire possesses more than double the tenacity just mentioned, and this with plain carbon steel, but the section of such product is so small that it hardly enters into the present discussion.

In the Seventh Report to the Alloys Research Committee on the "Properties of a Series of Iron-Nickel-Manganese-Carbon Alloys," by Dr. H. C. H. Carpenter, Percy Longmuir, and myself, we obtained an interesting exception to this rule, and produced somewhat remarkable results, which I will describe.

The particular portion of the experiments was carried out upon nickel steels containing varying percentages of nickel. The following is a list of these tests, the tensile strength being taken at the temperature of liquid air, that is —182 deg. C.

Iron-Nickel Alloys Made by Hadfield.

Tests at—182° C. (—295° F.)

Nickel alloy.	Analyses. C.	Si.	S.	P.	Mn.	Ni.	Tensile strength in tons per sq. in.	Elongation % on 2".
A	0.045	0.07	0.005	0.004	trace	...	42.0	nil
B	0.48	0.18	0.02	0.02	0.79	1.20	75.4	7.5
C	0.44	0.14	0.03	0.02	0.83	2.15	95.1	12.7
D	0.40	0.14	0.03	0.01	0.82	4.25	75.4	10.0
E	0.42	0.16	0.03	0.01	1.03	4.95	88.0	nil
F	0.52	0.10	0.02	0.01	0.92	6.42	142.2	2.5
G	0.43	0.17	0.02	0.02	0.79	7.95	91.1	0.5
H	0.41	0.17	0.01	0.01	0.85	12.22	87.2	..
J	0.45	0.08	0.02	0.02	0.83	15.98	144.2	2.5
K	0.41	0.13	0.02	0.01	0.96	19.91	157.2	15.5

Specimen A (Swedish charcoal iron) is added to represent the qualities of practically pure iron; this of course contains no nickel.

As will be seen from the above table, the specimens F, J, K showed most remarkable tenacities. All the bars were magnetic before and after testing, with the exception of K, which was only very slightly magnetic before being tested in liquid air; after the test it was strongly magnetic.

It will be seen that specimen K has not only the enormously high tenacity of 157 tons per sq. in., but is also accompanied by no less than 15 per cent. enlongation. Apart from steel in the form of wire, probably no such high tensile strength had ever before been obtained.

The tensile strength of K tested at normal temperature was 43.9 tons per sq. in., with 55 per cent. elongation on 2 in.

These results show that if in the future such a material is required, then in some artificial manner such high tenacity will be obtainable. The results are remarkable, seeing that the tensile strength of an alloy composed chiefly of the metal iron can be raised about 3½ times above its original strength.

This research was made several years ago, but at the time of the experiments I made up my mind that if such a tenacity could be produced artificially under the peculiar conditions in question, such results would probably be repeated later in some of the many wonderful alloys of iron with other elements which have been coming so much to the front of late years. In other words, that it might be expected that sooner or later the artificial conditions produced on the materials described in the above

experiment would be repeated in other alloys of iron which would afterward be discovered, or in alloys which by certain heat treatment could be made to reach this extraordinary physical condition. The term "extraordinary" is a word which can be justly used, seeing that the metal iron in its pure state has a tenacity of only 18 to 21 tons per sq. in.

As predicted, it has now been found that certain types of steel, chiefly those known as high speed steels, can by heat treatment be made to possess very high tenacity. Pierre Breuil, in his interesting report recently published on "La Metallurgie à l'Exposition Universelle et Internationale de Bruxelles de 1910," shows that certain specimens of Holtzer steel exhibited gave in several instances a tensible strength of no less than 135 tons per sq. in. I have recently been told by the present Master Cutler of Sheffield, Arthur Balfour, that it is now possible to obtain oil hardened steel with a tensile strength of about 150 tons per sq. in., such material having a tenacity in its normal condition of about 75 to 80 tons per sq. in.

From the various foregoing results of my own iron-nickel alloys and those of the Holtzer type, it would appear that metallurgists are gradually working up to a point where it may be possible to obtain in bar and other forms the same high tenacity which is obtained in finely drawn piano wire. As regards this material, it would be interesting if full authentic test data of such specimens could be furnished. At the moment I do not remember having seen authentic data of such material.

In any case, it is interesting to find that the high tenacity results obtained in the paper published several years ago, and previously referred to in this article, were, if one may term this so, not exceptional, also that the latest manufacturing results prove that what was predicted has come to pass.

These interesting facts are but another proof of how much there is still to be learned in the manufacture and development of the qualities of special steels, and that qualities which at one time would have been regarded as impossible of attainment can be produced.

The Pittsburgh Iron Trade in 1911

BY ROBERT A. WALKER

The year 1911 in the iron trade did not make a record to be commented on very favorably. The demand for all kinds of iron and steel in the opening months was light and mills ran on part time only. For a long period the market on finished iron and steel had been sustained only by close co-operation among the manufacturers and consumers were buying only such quantities of material as were absolutely needed. This condition continued until May 24, when the Republic Iron & Steel Company announced that it would act independently, making a cut of $3 a ton on prices of steel bars. This was met by the other steel interests, and shortly after prices on other products were reduced. These reductions did not have the effect of stimulating the demand, and from May there was a gradual decline that finally carried prices to the lowest levels reached in years. In October and November manufacturers made such price inducements that their customers became convinced that bargains were being offered to them, with the result that December 1 found the mills with orders for an enormous tonnage on their books. Prices then commenced to harden. The year closed with most products selling at fully $2 a ton higher than in November. The whole market had been on a wide open basis since May, yet there was no marked demoralization at any time, prices gradually declining until they reached a point that was attractive to consumers.

Pig Iron

The course of pig iron prices during the year is shown in the following table of average monthly prices of Bessemer, basic, No. 2 foundry and gray forge iron, f.o.b., Valley furnace, to which 90 cents per ton is to be added for delivery in the Pittsburgh district:

Average Monthly Pig Iron Prices, f.o.b. Valley Furnace in 1911.

Month.	Bessemer.	Basic.	No. 2 foundry.	Gray forge.
January	$15.00	$13.25	$13.94	$13.12
February	15.00	13.65	13.75	13.31
March	15.00	13.75	13.75	13.50
April	15.00	13.75	13.75	13.50
May	15.00	13.32	13.40	13.35
June	15.00	13.05	13.50	13.00
July	15.00	13.12	13.50	13.00
August	15.00	13.00	13.50	13.00
September	15.00	12.80	13.37	12.87
October	14.50	12.52	13.25	12.75
November	14.10	12.42	13.10	12.52
December	14.12	12.25	13.00	12.50

In the early part of 1911 and through the summer months the production of pig iron by furnaces in this district was at a minimum rate, owing to dull conditions in the steel trade. At one time during that period the United States Steel Corporation had less than 50 per cent. of its blast furnaces in operation. At the present time the total number of blast furnaces in the Pittsburgh district is 54. Of these the American Steel & Wire Company has 4; Carnegie Steel Company, 34; Clinton Iron & Steel Company, 1; Jones & Laughlin Steel Company, 10; National Tube Company, 4, and Pittsburgh Crucible Steel Company, 1. No new blast furnaces were built in the district in 1911, but No. 4 stack of the Jones & Laughlin Steel Company at Aliquippa, Pa., was completed in the early part of the year. The number is to be increased in the near future, however, as the Pittsburgh Steel Company has contracted with the Garrett-Cromwell Engineering Company, Cleveland, Ohio, for the building of two furnaces at Monessen to have a daily capacity of 500 tons each.

Steel Billets

The notable addition to new steel producing capacity in this district in 1911 was the completion of the four Talbot open-hearth furnaces of the Jones & Laughlin Steel Company at Aliquippa, Pa. This steel plant has not yet been put in operation, but will be in the near future.

The year opened with Bessemer billets quoted at $23 base and sheet and tin bars in random lengths at $24, f.o.b. Pittsburgh or Youngstown mill. These were really nominal prices, as most consumers have contracts, and practically only a small tonnage is sold in the open market. In May open-hearth billets were offered as low as $21.50, Pittsburgh, with the demand very light. In May, following the cut in merchant steel bars, the prices of billets and sheet bars were reduced $2 a ton, or to the basis of $21 for billets and $22 for sheet bars. These prices were fairly well maintained during June and July, at which time steel mills were running to 65 to 70 per cent. of capacity. By August 15 the demand had grown considerably better, the Carnegie Steel Company then being able to operate at about 82 per cent. of its total ingot capacity. By October 15, however, prices declined in sympathy with the reductions on other products. Billets were then offered at $19 or lower and sheet bars at $20, while the market was very dull. In November prices went off still further, open-hearth billets being offered at $18.50 or lower, being weaker than Bessemer. Early in December the open market on both Bessemer and open-hearth billets was $19 and on sheet bars $20 at mill. In the latter part of December, owing to the heavy bookings by the finishing mills, prices of semi-finished steel improved, and the year ended with both Bessemer and open hearth billets ruling at about $20 and sheet bars at $21, f.o.b. Pittsburgh or Youngstown mill.

Steel Rails

The building of the large rail mill at Gary, Ind., by the United States Steel Corporation has seriously interfered with operations at the Edgar Thomson mills of the Carnegie Steel Company and at no time in 1911 were these mills operated to more than 60 per cent. of capacity, the rate being even less at times. The demand for standard section rails was quiet nearly the whole year, no notably large contracts having been placed. In light rails

the situation was better. The Carnegie Steel Company has had under consideration for a long time the matter of making material changes at its Edgar Thomson works, adding some new finishing mills to take the output of steel, but so far nothing definite has been done. Prices of standard sections remained at $28 throughout 1911, but light rails declined $2 to $3 a ton from rates ruling in the early part of the year, this being caused largely by the competition of mills that reroll from old standard sections.

Structural Material

The year opened with new inquiries light, 15-in. beams and channels ruling at 1.40 cents, Pittsburgh, but with very little new work in sight. Conditions did not materially change until in March, when the demand showed some betterment. In June 15-in. beams and channels were openly quoted at 1.35 cents, but this price was being materially shaded, fabricators making bids on erected work on a much lower basis. In August the McClintic-Marshall Construction Company took 3400 tons of additional work for the Panama Canal and the American Bridge Company took about 5000 tons for the Union Bridge in this city, and a record low price was made on this job. In September the Bethlehem Steel Company took 2600 tons for the addition of 22 stories to the First National Bank Building in this city, of which 1500 tons were Bethlehem sections, the other 1100 tons being rolled by the Carnegie Steel Company.

The formal contract for 59,000 tons of plates, shapes and bars for the Quebec Bridge was signed in October, the material to be rolled by the Carnegie Steel Company. In that month the American Bridge Company took 36,000 tons for the Hell Gate Bridge in New York City. In November 15-in. beams and channels were selling as low as 1.05 cents and fabricated work was going at extremely low prices. In the early part of December the bookings of the American Bridge Company and other structural intersts were enormously heavy and the mills advanced prices on 15-in. beams and channels to 1.15 cents minimum, but fabricated work was still going at low prices. Late in December the Jones & Laughlin Steel Company took 9500 tons of steel for the Railway Exchange Building in St. Louis. The year closed with the fabricating shops of the American Bridge Company filled up for six months or more of 1912, and the other fabricating interests having a fair amount of work on their books.

Plates

The demand during the first half of 1911 was so slack that at times the larger mills were running to 50 per cent. or less of capacity or were shut down entirely, waiting for enough orders to accumulate to warrant their starting up. The year opened with ¼-in. sheared plates ruling at 1.40 cents, Pittsburgh, and this price continued in force until May, when a reduction was made to 1.35 cents. Very little new business was booked by the mills at this price, and it was materially shaded from the time it was named. In October and November ¼-in. plates were selling at 1.10 cents and in many cases 1.05 cents was done. These low prices stirred up the railroads and orders for steel cars commenced to come on the market. The car builders bought plates so heavily to fill car orders that in the early part of December the mills advanced the price on plates to 1.15 cents minimum. The year closed with the Homestead plate mills of the Carnegie Steel Company operating to practically full capacity and the other mills running at a heavier rate than at any time during the year.

Iron and Steel Bars

A fair demand for hard steel bars for concrete reinforcement purposes marked the opening of 1911, but orders for soft steel bars and iron bars were scarce. Soft steel bars were held at 1.40 cents and common iron bars at about 1.35 cents, Pittsburgh. These prices, however, were sustained by co-operation among the makers and the trade was buying only what was absolutely needed. The market continued in this condition until May, when the Republic Iron & Steel Company made its cut on steel bars to 1.25 cents. This cut was immediately met by the other makers, and some heavy contracts were placed at the new price, with a guarantee against a decline. The amount of new business taken on the lower rate was less than had been expected, and the natural result was that prices sagged further. In October and November steel bars sold as low as 1.05 cents on very desirable contracts for forward delivery.

Consumers realized that this was an extremely low price and contracts were rushed into the mills at an enormous rate, with the result that early in December the Republic Company announced that its price of steel bars was 1.10 cents for December delivery and 1.15 cents for first quarter. This was followed very soon by another announcement from the same company that its minimum price of steel bars was 1.15 cents, and the other makers also advanced their prices. The year closed with the steel bar mills having orders for an enormous tonnage on their books for first-quarter and first-half delivery.

The demand for iron bars was quiet during the entire year. Pittsburgh, however, does not take a prominent place in the bar-iron market. The year opened with iron bars ruling at about 1.35 cents, but this price declined to about 1.20 cents, recovering to about 1.25 cents at mill.

Merchant Pipe

The year in the merchant pipe trade was fairly satisfactory. The mills were able to operate most of the year to between 60 and 70 per cent. of capacity, although at certain periods they got down to 35 or 40 per cent. Orders for pipe for some very large gas and oil lines were placed during the year. The largest of these was the Calgary order, which went to the National Tube Company, involving about 30,000 tons. No deliveries have yet been made on this order.

The discounts in effect at the first of the year remained unchanged until October 2, on which date the manufacturers issued a card showing a reduction of one point, or $2 a ton, on black steel pipe, $6 to $12 a ton on galvanized steel pipe, and $2 a ton on extra strong and double extra strong pipe. Regular discounts had been more or less shaded for some months, and the new card seemed necessary to meet actual conditions. On December 1 another card was issued, which named a reduction of one point, or $2 a ton, on black and galvanized butt weld pipe, and two points, or $4 a ton, on black and galvanized lap weld pipe. These discounts were in effect at the close of the year. December bookings of the pipe mills were much larger than usual in that month.

Iron and Steel Scrap

Low prices were realized on scrap nearly the entire year, the consumption being much less than normal owing to the light operations of steel plants. Heavy steel melting scrap sold as low as $12 a ton. In November and December the Jones & Laughlin Steel Company bought 50,000 tons or more of heavy steel scrap, while the Republic Iron & Steel Company was also a buyer of considerable scrap for its new open-hearth plant. The year closed with a slightly better feeling in the scrap trade and some recovery in prices. The following table shows average monthly prices, all per gross ton, at Pittsburgh, of heavy steel scrap, No. 1 foundry cast, bundled sheet scrap, rerolling rails, cast-iron borings and machine shop turnings during 1911:

Average Prices of Scrap at Pittsburgh in 1911.

Month.	Heavy steel scrap.	No. 1 foundry cast.	Bundled sheet scrap.	Rerolling rails.	Cast iron borings.	Machine shop turning.
January	$13.50	$13.25	$9.44	$14.75	$7.97	$8.60
February	14.12	13.56	10.44	14.81	8.44	9.05
March	14.35	14.30	10.80	15.00	9.25	10.10
April	13.06	13.81	9.19	14.50	8.71	9.41
May	12.70	13.55	9.30	13.70	8.76	9.09
June	12.94	13.37	10.37	13.50	8.75	9.04
July	13.06	13.25	11.00	13.62	8.81	9.06
August	13.20	13.25	11.65	13.55	9.30	9.60
September	12.75	12.87	11.00	13.37	9.06	9.20
October	12.06	12.50	10.31	12.87	8.25	8.81
November	12.00	12.19	10.25	12.50	8.31	8.87
December	12.25	11.25	10.25	12.50	8.75	9.00

Coke

The coke trade during 1911 was far from being satisfactory to the operators, prices being low during the entire year and the demand generally dull. In the summer months the trade was very much depressed, large stocks of coke being piled up at the ovens, and in some cases standard makes of Connellsville furnace coke for spot shipment were sold as low as $1.40 to $1.45 per net ton at oven.

Conditions improved somewhat in the last two or three months of the year, and prices also showed some better-

ment. A labor shortage then developed, and this resulted in stocks of coke being worked off. Some heavy contracts for furnace coke for delivery through the first half and some for all of 1912 were made in December, most of them at $1.65 at oven, but in a few cases $1.70 is reported to have been obtained.

The New Year

The outlook for 1912 is fairly good. The mills enter the year with their order books filled for some months ahead. It is true that this business was taken at very low prices, but the prospects are good of getting higher prices from consumers who failed to get under cover when given the chance to do so. While 1912 is a Presidential year, it is hoped that this may not retard business to any great extent. The belief is general that at least for the first half of 1912 the mills will have nearly as much business as they can handle. Prices will probably continue to rule comparatively low in 1912, as so much new producing capacity has been added in the last two or three years that more than a few months may be required for the consumption to grow up to it.

The Chicago Iron Trade in 1911

BY O. J. ABELL

No legacy of well-filled order books was handed down from 1910, and the paucity of business was such that as early as January manufacturers were confronted with the problem of whether business might be increased and improved by further reductions in price. With the exception of the moderate increases in buying which made March and July banner months in the first three-fourths of the year, thereby temporarily raising hopes of better things, the nine months of that period were monotonously depressing. A general lack of orders involving much tonnage, which held the mills down to an operating schedule of 50 to 70 per cent., and blast furnaces to less, prevailed.

Chicago Suffered More than the East

In proportion to its producing capacity, and particularly its increase in capacity, the Chicago district seemed to suffer to a greater extent than did the East. Business interests seemed more intent in establishing the reasons for suspended activity, based on Supreme Court decisions, the Sherman law and the activities of the Department of Justice, than in effecting a cure.

Until June, despite a disappointing decrease in buying following March, prices were maintained practically on the January basis. In every year of depression the month of June, when the agricultural implement manufacturers place their yearly contracts for steel bars, is a crucial period. The past year was no exception, and as a precautionary measure the sentiment of manufacturers was sounded and the general belief established that prices would continue without change. Yet almost immediately one of the leading companies making steel bars and having large contracts with Western bar users announced that it was accepting contracts at a reduction of $3 per ton. The general steel bar market followed this cut, but the confidence of buyers in the stability of prices at the new level was not immediately established and contracting for bars dragged. Continued lack of orders and an insistent buying pressure began to make themselves felt in the price of plates and structural material, weaknesses began to appear and a gradual decline amounting to $1 a ton in September followed. The keenness of unhampered competitive selling grew apace.

The Summer and Autumn

In August the activity of the market was enhanced by a limited buying of rails, of which 50,000 tons were ordered from Chicago mills. Moderate purchases of cars seemed imminent, but the more important inquiries were withdrawn after figures had been taken. September was again disappointing, and apparently the basis for trading was not yet "right."

The eagerness of some of the mills for business, the more keen because of their whetted appetites, culminated October 1 in a reduction of $2 a ton on plates and structural material and wide irregularities in the prices of sheets. The immediate effect was confusion among the selling interests and the complete destruction of confidence among the buyers. Purchases were for immediate needs only and the aggregate tonnage was no better than in September.

An unleashed scramble for orders ensued. Tonnage was the one consideration. The nominal market sank to a lower level than had prevailed for years and special transactions brought out prices into which costs were never figured. But apparently the basis for trading was at last financially correct. Inquiries for railroad cars began to appear, and before November was over more buying had been done than in all of the months preceding. Not until December, when tonnages had piled up on the mill books sufficient for three months' operations, did the market show signs of returning strength and price advances appear.

Departures from the Pittsburgh Basing Price

The Chicago territory, with its differential above Pittsburgh prices, offered a field for a wider range of price concessions, and an interesting phase of the local market situation during the last half of the year, following the first reductions in price in June, was the departure of quotations for Western delivery from the Pittsburgh basing price. In October local competition became so keen that for Western business the freight differential, especially on plates, structural material and steel bars, was sacrificed in proportion as the particular sale required. The Chicago price thus dropped from $1 to $3 in extreme cases below the Pittsburgh base, plus freight to Chicago. At one time a portion of Eastern competition was entirely shut out from this territory. In the slight recovery which has been materializing since November the prices have paralleled each other, with a tendency shown to resume the Pittsburgh basing price for this market.

It is of interest to note that in November some sales of steel bars were made at the going price of bar iron. As a result a considerable tonnage of this cheap steel was bought in preference to bar iron, and the bar iron mills have thus been sufferers not only from the quiet market demand for their product, but also from the competition of steel bars.

Under ordinary conditions Northern pig iron may be sold in competition with Southern iron in this market at a premium of 50 cents per ton, but the record of the past year shows that the continued competition for the little business that existed gradually depressed the values of both irons and established their prices alternately one above the other. At the close of the year Southern iron occupied the stronger position of the two.

Railroad Buying

Until the buying movement of November and December the mills and furnaces had been forced to operate practically without tonnage from the railroads. The buying movement of the last quarter emanated almost entirely from the railroads, and the general business which had supported the market during the earlier months of the year noticeably decreased. An aggregate of 20,000 cars was bought by the leading Western roads and orders for an additional 10,000 cars were placed with Western car builders by the smaller roads and trunk lines running eastward. The Santa Fé system purchased 20,000 tons of rails and the Burlington 50,000 tons. At the close of the year other Western railroads had under consideration the purchase of approximately 75,000 tons.

Estimating the iron and steel for all purposes entering into the above cars at 15 tons per car, it is apparent that orders for approximately 450,000 tons were placed with the foundries, furnaces and mills of this district. The pig iron market as well as that for finished steel products felt the impetus of this heavy buying movement, and in November and December the demand for both Northern and Southern iron in this district was very active.

The record of the year offers little opportunity for citing important tonnages in orders placed prior to the last quarter. In any year, however, the erection of steel buildings such as have been built in the downtown district of Chicago in the past 12 months would be notable for the quantity of steel required and the value of the work simultaneously in process of construction. In August there was in some stage of completion about 70,000 tons of steel frame buildings valued at $25,000,000, and additional building permits, taken out to anticipate a new building ordinance, had been issued covering new structures requiring 50,000 tons and valued at $20,000,000.

Sufficient business has been placed on order books to secure practically full operation through the first quarter of 1912. It is estimated that ample material is in sight, still to be purchased, to provide for the second quarter. Beyond this the question of business continuing in large volume apparently depends upon how attractive banking interests will find long-term issues of bonds and mortgages

Comparison of Prices

The following tables show the course of prices in the Chicago market, compiled from the weekly reports in *The Iron Age:*

Average Chicago Prices of Pig Iron, 1911.

Month.	Northern coke No. 2.	Lake Superior charcoal.	Southern coke No. 2.
January	$15.50	$17.88	$15.35
February	15.50	17.50	15.35
March	15.50	17.50	15.35
April	15.25	17.50	15.35
May	15.00	17.25	15.29
June	15.00	16.88	14.63
July	14.88	16.50	14.35
August	14.50	16.50	14.55
September	14.50	16.50	14.41
October	14.44	16.50	14.35
November	14.20	16.50	14.35
December	14.15	16.50	14.25
Average for year	$14.87	$16.96	$14.80
Average for 1910	$17.10	$18.67	$16.30
Average for 1909	17.49	19.50	17.30
Average for 1908	17.57	20.24	16.76
Average for 1907	24.50	26.56	24.47
Average for 1906	20.43	20.72	19.44
Average for 1905	17.65	17.99	16.66
Average for 1904	14.37	15.50	13.92
Average for 1903	19.25	22.13	18.31
Average for 1902	20.86	23.50	20.10
Average for 1901	15.38	17.50	14.60
Average for 1900	19.47	22.00	18.35

Average Chicago Base Prices of Finished Iron and Steel, 1911.

Month.	Common bar iron. Cents.	Soft steel bars. Cents.	Structural shapes. Cents.
January	1.30	1.58	1.58
February	1.30	1.58	1.58
March	1.28	1.58	1.58
April	1.25	1.58	1.58
May	1.23	1.58	1.58
June	1.20	1.43	1.55
July	1.20	1.43	1.53
August	1.20	1.43	1.53
September	1.21	1.38	1.50
October	1.17	1.25	1.38
November	1.15	1.15	1.33
December	1.14	1.20	1.33
Average for year	1.22	1.47	1.50
Average for 1910	1.45	1.62	1.66
Average for 1909	1.43	1.50	1.59
Average for 1908	1.56	1.66	1.82
Average for 1907	1.78	1.77	1.87
Average for 1906	1.71	1.68	1.86
Average for 1905	1.65	1.65	1.78
Average for 1904	1.41	1.50	1.71
Average for 1903	1.65	1.72	1.75
Average for 1902	1.71	1.73	1.75
Average for 1901	1.58	1.58	1.70
Average for 1900	1.75	1.75	2.00

Average Chicago Prices of Old Material, 1911.

Month.	Old iron rails. Gross ton.	No. 1 railroad wrought. Net ton.	Heavy cast scrap. Net ton.	H'vy melting steel scrap. Gross ton.	Old steel rails, rerolling. Gr. ton.
January	$15.00	$11.75	$12.19	$11.75	$13.69
February	15.25	12.00	12.13	12.06	13.63
March	15.35	12.30	12.25	12.15	13.65
April	14.69	11.69	11.81	11.75	13.44
May	14.69	11.38	11.00	10.50	13.19
June	14.38	11.25	10.75	10.38	12.38
July	14.25	11.00	10.50	10.69	12.25
August	14.25	11.10	10.55	11.05	12.65
September	14.50	10.94	10.10	10.70	12.75
October	13.88	10.44	10.25	10.00	12.44
November	14.75	10.20	10.35	9.75	12.30
December	15.00	10.75	11.00	10.25	12.50
Average for year.	14.67	11.23	11.08	10.92	12.91
Average for 1910.	17.34	12.99	13.32	13.43	16.34
Average for 1909.	18.31	13.76	13.79	14.45	15.82
Average for 1908.	16.60	12.45	12.69	12.45	....
Average for 1907.	22.47	14.63	17.26	15.08	....
Average for 1906.	23.04	15.62	14.55	14.74	....
Average for 1905.	20.18	16.14	13.50	13.97	....
Average for 1904.	16.56	12.45	10.95	10.72	....
Average for 1903.	20.29	16.07	14.75	15.50	....
Average for 1902.	23.91	19.68	15.03	17.37	....
Average for 1901.	19.50	15.00	11.25	....	....
Average for 1900.	17.90	15.00	11.00	....	....

The Philadelphia Iron Trade in 1911

BY A. A. MILLER

Uncertainty as to even near future conditions kept the trade in an unsettled state almost throughout the entire year. Producers, as well as consumers, found it difficult to plan ahead, and short periods of activity were speedily followed by corresponding intervals of dullness. Each recurrent spurt of buying was usually at the expense of prices. National affairs had an important bearing on the business situation, not only influencing railroad buying, but keeping the trade generally in a state of unrest.

General Conditions

The year opened under inauspicious circumstances. Mills were operating at a basis far below capacity. Consumers of all classes were making purchases against imperative needs only, while producers were keeping production at a minimum. This was particularly the case in connection with the pig iron output, the rate in this district being closer to the lines of consumption than ever before.

The activity of finishing mills increased a trifle early in the spring and midyear found them on about a 75 per cent. basis, but this declined toward the close of the year. Early in the summer there was a slight general reduction in the prices of rolled products, but it was not sufficient to induce any extensive buying. Further slight general concessions also failed to bring the desired result. It was not until later in the year, when open competition for business was in full effect and the old policy of uplifting the market by getting under it was adopted, that a betterment in the demand was experienced.

Extremely low prices on practically all classes of products then induced more active conditions in almost all directions, railroad buying increased largely, shipbuilding became active and considerable bridge and development work was undertaken. Consumers began to fill up depleted stocks and contracts for extended delivery again came out. While this aggregated an enormous tonnage, the larger proportion of it went to Western mills, which steadily increased their production. The same rate of gain was not experienced by the Eastern mills, owing to their refusal to meet the extreme concessions made by their competitors, and in many cases they closed the year on about the same basis as they were operating at the beginning of 1911.

Iron Ore

While the demand has been rather quiet, the year has not been bare of important transactions, the most noteworthy being the sale of 3,000,000 tons of Swedish ore to the Bethlehem Steel Company, for delivery over a period of nine years, deliveries ranging from 250,000 to 350,000 tons a year.

The principal buying was early in the year, but the volume in general was smaller, due to the fact that considerable ore was carried over from 1910. While full prices were obtained early in the year—in fact, in instances advances were recorded—readjustments followed in a number of cases in the summer, due to the unsatisfactory condition of the pig iron market. The total 1911 imports at Philadelphia probably slightly exceeded 1,000,000 tons, as compared with 1,165,961 tons in 1910 and 992,036 tons in 1909. The largest importations are from Cuba, then from Sweden, Spain, Newfoundland, New Brunswick, and the Mediterranean, in the order named.

Pig Iron

Producers in eastern Pennsylvania, as well as in Virginia, had the situation well in hand throughout the year. From the statistical standpoint the position has been strongly in favor of the seller, but the extreme conservatism of buyers held the market within narrow lines. The figures of the Eastern Pig Iron Association show a most uniform monthly record as to unfilled orders on hand, the total in December being about 10 per cent. in excess of that in January. Stocks on furnace yards showed an almost constant decline, being in December 15 per cent. lower than in January and 20 per cent. lower than in March. At the close of the year stocks on furnace yards amounted to less than 100,000 tons, or not quite two weeks' supply. An unusual proportion of the stock on hand in December was composed of basic and other special grades, that of foundry grades being lower than for years. This accumulation of basic, some 20,000 tons, was due largely to deferred shipments ordered by some of the Eastern steel mills.

Data compiled by the Virginia Pig Iron Association show a somewhat irregular decline in unfilled orders reported from month to month. At the close of the year unfilled orders showed a decline of 47 per cent., as compared with the beginning of the year, due largely to the fact that buying during the greater portion of the year was from hand to mouth, and bookings late in the year represented largely sales for early shipment. Stocks on Virginia furnace yards were highest at the beginning and lowest at the close of the year, the falling off being represented by a decline of about 10 per cent. Of the stocks on hand the leading Virginia producer was carrying about 170,000 tons, or 83 per cent of the total.

Price fluctuations of the various pig iron grades were at a minimum during 1911. Buying at no time reached such proportions that sharp advances were made. The range of prices in nearly all grades was continually downward. Each buying movement of any consequence brought out some slight concession, due largely to efforts of producers outside the territory to enter the market and the ultimate meeting of such concessions by Eastern producers.

During the greater part of the year pig iron purchases were made in small lots for near-future needs, but in the closing months, when prices were at the lowest, heavy orders were placed, in instances covering deliveries over the first half of 1912, and December found producers with order books in better shape than almost any time during 1911, with prospects of increased production favorable, as with the limited capacity many sellers had their product for the next four to six months pretty well taken.

The accompanying table shows the average range of minimum quotations by months for the principal grades of pig iron delivered in buyers' yards, eastern Pennsylvania and nearby points:

Average Prices of Pig Iron Delivered in Buyers' Yards, Eastern Pennsylvania and nearby Points in 1911.

	Penn. No. 2 X.	Virginia No. 2 X.	Standard gray forge.	Basic.	Standard low phos.
January	$15.50	$15.80	$14.25	$14.25	$21.75
February	15.50	15.80	14.25	14.44	21.25
March	15.50	15.80	14.60	15.25	21.35
April	15.50	15.80	14.75	15.19	21.50
May	15.50	15.61	14.69	14.75	21.00
June	15.25	15.05	14.50	14.50	20.60
July	15.00	15.05	14.50	14.38	20.50
August	15.00	15.00	14.30	14.65	20.00
September	15.00	15.00	14.44	14.69	20.00
October	15.00	15.00	14.25	14.50	20.00
November	14.95	15.00	14.25	14.50	19.55
December	14.85	15.00	14.25	14.25	19.25

Plates and Structural Material

The demand has been irregular and mills operated on an unsatisfactory basis almost throughout the year. At the opening of 1911 Eastern mills were operating at about 50 per cent. capacity, which in March was increased to 75 to 80 per cent., but decreased in April to 70 per cent. June brought a slight recovery, with mills at 80 per cent. capacity, and for intermittent periods some operated at close to full capacity. In July the demand was easier and 70 per cent. about represented operations, declining again in September to 60 per cent., which about represented the average for the remainder of the year.

Prices were firm at 1.55 cents, delivered here, up to June, when they were reduced to 1.50 cents, which quotation held until August, when prices gradually sagged off until 1.25 cents was quoted on sharp competition. Few Eastern producers, however, met the extreme quotation, and the bulk of the business offered, which increased largely during the last quarter, went to mills outside the district. In December extreme low figures began to disappear and 1.30 cents to 1.40 cents represented the market, but even at this basis Eastern mills did not take sufficient business to enable the productive rate to be increased.

Sheets and Bars

Eastern sheet mills operated on a very irregular basis during 1911. At times they were able to run at full capacity, but at no time was this rate maintained for any lengthy period. Frequently orders were so light that it was difficult to prepare rolling schedules more than a few days ahead. Orders were small, as a rule, consumers buying from hand to mouth and urging shipments. Prices for ordinary No. 28 black sheets were maintained at 2.35 cents, delivered here, during the first five months of the year; in June they declined to 2.15 cents; in August 2.10 cents was quoted; in September 2.05 cents, and in October 2 cents, the low level of the year, was reached. Active buying during the closing months of the year brought prices up to 2.05 cents. Eastern mills making smooth loose-rolled sheets maintained an advance of ¼ to ½ cent per lb. over the prices quoted, which are for Western sheets, delivered in this district.

Iron bars were quoted at 1.32½ cents minimum, delivered in this district, early in 1911, and after a decline to 1.30 cents in February advanced to the highest mark of the year in March, when 1.37½ cents prevailed. A gradual falling off then followed almost to the close of the year. In April 1.32 cents was reached; in May 1.30 cents; in July 1.27½ cents; this quotation held until late in September, when 1.22½ cents was reached, while in November sales were made at 1.20 cents. In December there was a partial recovery to 1.25 cents minimum. The downward trend was not followed by all producers, some of whom did not go below 1.27½ cents. Business with iron bar mills was extremely irregular.

Prices of steel bars were well maintained up to June at 1.55 cents, delivered here, when they declined to 1.40 cents; in September to 1.35 cents, and in October to 1.30 cents. Sharp competition and an open market drove prices down to 1.20 cents in November, while in December an upward turn resulted in 1.25 cents being quoted for prompt and 1.30 cents for forward deliveries.

Old Material

Dullness characterized the market at the beginning of the year. In February and March an increase in demand brought a slight upward movement in prices, but it was short in duration, a general downward tendency developing in April and continuing until the closing month of the year. At times efforts were made to force prices to a higher level, but these were generally unsuccessful. Mills operating at a reduced productive rate required less old material, and offering prices were lower on each successive movement. Occasional buying would bring about higher prices for a few weeks, but recurrent dullness usually brought them back to the old level.

Bargain lot buying was a feature in heavy melting steel for a large part of the year. The movement in rolling mill grades depended on mill activities, which were irregular at the best. As the price levels became lower the usual spread between bids and offers became narrower, and frequently 25 cents represented the full spread of the market on some grades. At times the movement in special grades, such as old iron and steel axles, iron rails, etc., was at a standstill for weeks at a time, and quotations were entirely nominal. In instances the market was purely a dealers' market. Mills were taking deliveries against previous orders and practically out of the market, while dealers were paying higher prices than mills would offer, and applying the materials against old higher-priced contracts. Frequently it was difficult to stir up a buyer for any grade, except at sacrifice prices.

Toward the close of the year consumers gave the market more attention. A better movement in nearly all grades was reported, but transactions were usually in such small lots that prices were not materially affected. In December

there was a general uplifting of prices and buyers began to cover more freely, owing largely to the approaching winter season and better demand in general.

The range of quotations, showing the monthly average minimum price for the leading grades, delivered in buyers' yards in this territory, taking a freight rate varying from 35 cents to $1.35 per gross ton from Philadelphia, is given in the accompanying table:

Average Prices of Old Material, Delivered in Buyers' Yards in Eastern Pennsylvania, in 1911, Per Gross Ton.

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
No. 1 heavy melting steel scrap	$12.50	$13.50	$14.05	$13.31	$13.00	$13.00	$13.19	$13.15	$12.50	$11.94	$11.55	$12.08
Low phosphorus heavy melting steel scrap	17.75	17.75	18.40	17.75	17.00	16.75	16.75	16.75	16.75	16.38	15.55	15.50
Old iron rails	17.00	17.38	18.50	17.50	16.75	16.60	17.06	17.40	17.00	16.38	15.50	15.67
Old car wheels	13.00	13.44	14.00	13.19	13.00	13.10	12.94	13.00	12.56	11.75	11.35	12.33
No. 1 railroad wrought	15.63	16.06	17.20	16.06	15.25	15.00	15.13	15.70	14.75	13.94	13.85	15.00
Wrought iron pipe	12.31	13.13	13.95	13.56	12.69	12.10	12.56	12.90	12.00	11.44	10.85	11.42
Wrought turnings	8.12	9.19	10.00	8.81	8.25	8.40	9.00	9.30	8.19	8.00	8.00	8.91
Cast borings	8.12	8.81	9.60	8.25	7.75	7.90	8.63	8.80	7.69	7.50	7.50	8.09
Machinery cast	14.00	14.38	14.40	13.44	13.13	13.00	13.06	13.20	12.69	12.44	12.25	13.00
Railroad malleable	12.81	12.06	12.50	12.00	11.63	11.50	11.50	11.50	11.13	11.00	11.00	11.67
Stove plate	10.00	10.25	11.30	10.50	10.25	9.85	10.19	10.40	9.69	9.25	9.25	9.91

The Copper Trade in 1911

BY L. M. ATHERTON.*

The greater part of 1911 in the copper trade was most adverse to the producing interests. Conditions for the three previous years had been unsatisfactory, and with the advent of new productions from the porphyries 1911 was expected to show a substantial increase in output. Notwithstanding that the world's visible supply of copper decreased 76,000,000 lb. in 1910 and the downward movement was still in progress at the close of the year, the feeling was widespread that the prevailing quiet business conditions in the United States would not fail during 1911 to be the cause of smaller takings by the consuming interests. This was true in the main, as is evidenced by the steady increase in the American surplus during the first five months of the year, although this increase was quite as much the result of consumers depleting supplies in their own yards at the expense of the refiners. In other words, the visible supply increased while the invisible supply was decreasing. But there was another factor to be reckoned with—the improving foreign demand, which continued almost without cessation throughout the year. This was an unexpectedly favorable symptom which took a long time fully to be recognized. The result was that during November and December the copper metal market was stronger than even the most sanguine had hoped.

The Decrease in Refinery Output

The production of copper is supposed theoretically to increase about 6 per cent. per annum. Not only did this normal increase fail to materialize in 1911 but there was an actual decrease as compared with 1910 when the refinery output was 1,452,000,000 lb. The surplus stock of copper in the United States decreased about 26,000,000 lb. during the year as shown by the following table (partly estimated):

	Pounds.
Stocks January 1, 1911	122,030,195
Production (refinery output)	1,429,000,000
Domestic deliveries	713,000,000
Exports	742,500,000
Total deliveries	1,455,000,000
Excess deliveries	26,000,000
Stocks January 1, 1912	96,000,000

On January 1, 1911, the foreign visible supply was 187,700,000 lb. but during the year there was an almost constant drop until at the present time it is in the neighborhood of 125,000,000 lb., a decrease in 1911 of over 62,000,000 lb. and comparing with the maximum of 254,000,000 lb. in March, 1910. Various reasons have been assigned for this state of affairs abroad, and it was felt for some time that some of the copper which was exported from the United States was not going into consumption. This theory has been exploded, and it is now generally conceded that an unusually sound business situation has had its natural effect in decreasing the foreign supply of copper.

For the year the world's visible supply decreased about 88,000,000 lb. as shown by the following table (partly estimated):

	United States	Foreign	Total
Stocks January 1, 1911	122,030,195	187,705,280	309,735,475
Stocks July 1, 1911	157,434,164	157,184,280	314,618,444
Stocks January 1, 1912	96,000,000	125,000,000	221,000,000
Decrease for year	26,000,000	62,000,000	88,000,000

This showing is now being reflected in advancing prices for the metal.

*Boston News Bureau.

The Course of Prices

The year opened with electrolytic copper selling at 12¾ cents per lb., New York, but this price was not long maintained, and before the month of January was over a reduction to 12½ cents was made, at which price fairly heavy sales were made. Up to November 1 the course of prices was distinctly disappointing, the monthly average for electrolytic never getting appreciably above 12½ cents per lb., and in one month, in May, being about 12 cents.

At various periods during the year there was spasmodic improvement, as, for example, in the latter part of June, when for a week the price was about 13 cents. This was followed by another decline to 12⅜ cents in the latter part of September. Commencing November 1, the American consumer made his presence felt and in less than two months there was a rise of practically 2 cents per lb., so that the December average of about 14 cents was easily the highest of the year.

The low metal prices were naturally reflected in declining quotations for copper shares, some of which sold even lower than during the 1907 panic. Speculative and investment interest was practically non-existent during ten months of the year, a situation that was aggravated by a reduction in dividends by many companies. Confidence was further shaken by the publication in August of a report on the Lake Superior district which claimed that nearly all of the mines there were even at the then prevailing low prices selling in the stock market for considerably more than they could ever pay back in dividends.

Mine Developments

There were no mining developments of extraordinary importance during the year. Several new porphyry mines,—Miami, Ray Consolidated and Chino—started production, but the total output of refined copper from these mines was not more than 50,000,000 lb. at the outside. To offset this there was enforced curtailment by several properties, notably Shattuck-Arizona, First National, Imperial and Granby, probably not less than 30,000,000 lb. Some of the vein mines, too, outputted considerably less copper than in 1910, against which, however, there was an increase by some of the newer properties, Utah, for example. The total mine output of the United States was not substantially changed from 1910.

Early in the year an attempt was made by the Calumet & Hecla Mining Company to form a consolidation of 12 companies operating in the Lake Superior district. After considerable litigation the merger was finally abandoned in the latter part of the year.

In January the Amalgamated Copper Company took over the United Metals Selling Company, which had previously sold the output of Amalgamated and other producers. This gave to Amalgamated the selling of about 450,000,000 lb. of copper per annum and made it the largest seller of copper in the world.

Perhaps the most significant event was the purchase of the Live Oak property by John D. Ryan in December, thus marking the entrance into the porphyry field of the Amalgamated interests, who had previously confined themselves to the vein mines.

The agreement to control production 15 per cent. expired August 1, but increased mine production has not since been evident except in a few instances. The agreement served its purpose in keeping much copper from the market that would otherwise have been produced.

The Outlook

The outlook is undeniably more promising than for a long time. Competent judges maintain, and seemingly with reason, that after such a long period of depression the copper producers may logically look forward to at least reasonable prosperity for some time to come. The present price of copper seems to be the result of a combination of circumstances which make for reasonably sound fundamentals. There are no excessive stocks of the metal in sight and general business in the United States is slowly working into better shape. These conditions, taken with the satisfactory foreign situation already referred to, are believed to indicate that a steady demand for copper will be seen. Within the next year or two there may be expected a substantial increase in production as a result of additional porphyry mines coming into productivity, but the natural increase in consumptive requirements may fairly be assumed to be able largely to take care of the increase. Moreover, it is worthy of note that there was not discovered in 1911 any new mine of importance. The mines which will be responsible for an immediate increased output were under development previously, so that taking a long range view the new production, rather than being a disturbing element, is likely to be of benefit in maintaining a stable price for copper. Very many of the mines are, and have been for some time, producing practically at full capacity so that increased production must necessarily come from new properties.

Both producers and consumers may look forward to 1912 with confidence, the former to a good demand for their product at prices which should permit of profitable operation, the latter to a reasonable supply of the metal always in sight which would prevent the possibility of a runaway market.

The Sheet and Tin Plate Trades in 1911

BY B. E. V. LUTY

The year 1911 was a very trying one to the sheet and tin plate manufacturers, being particularly so to the sheet manufacturers. In common with other branches of the finished steel industry, the sheet and tin plate trades suffered from a demand which fell very materially below the capacity, but in the sheet trade there was competition keener than existed in other branches of the steel industry, having regard to the excess of capacity over demand. This arose, perhaps, from the number of individual interests engaged in manufacturing sheets.

Lowest Prices in History of the Trade

Judging by the course of prices, there must have been a number of sheet producers who were absolutely invertebrate. For a period of several weeks, from late October to early December, the open market price of both black and galvanized sheets ruled at a lower level than had ever before been seen in the history of the industry. While all finished steel prices were low, such a statement could be made of but one other branch, the price of merchant steel pipe also falling below its lowest previous record.

The historic low prices in sheets had been made in 1898. For a short time during the summer of that year, and again late in the year, the price of No. 28 black on desirable orders fell to 1.85 cents, Pittsburgh. The price of galvanized, then quoted as a discount from list, was much higher in proportion to black than is the case now, so that galvanized sheets need not be considered. In the recent period mentioned a few orders, even down to single carloads, are believed to have been taken at 1.75 cents, at mill, for No. 28 black, and large tonnages were sold at 1.80 cents, so that prices of black sheets fell $1 to $2 a ton lower than ever before seen. At the same time galvanized sheets sold at little if any greater spread above black than $1 per 100 lb.

Nearly all costs in the iron and steel industry are much higher now than in 1897 and 1898, when practically all the record low prices were made in pig iron, billets, sheet bars and finished steel. Common labor is much higher, and fuel, a heavy item in the case of sheet and tin plate manufacture, is higher. Ore is more expensive to mine, and there are added costs all along the line, including higher freight rates.

In one item, the tonnage wages at the hot mills, costs are lower in the sheet industry, and this by approximately $2 a ton. Precise comparisons cannot be made, for, while the present wage scale is a tonnage scale throughout, the scale until a few years ago was part tonnage and part day rates, the cost per ton of the day hands at the sheet mill being dependent upon the tonnage output. Outputs per mill are much heavier now than in 1898, it is true, and this helps to distribute overhead charges, but at the same time the overhead charges are much higher. Rolls and machinery in general cost much more per lb. and the increased output per mill is obtained chiefly by making the mills and engines much heavier, so that the increase in tonnage is not a net gain.

The low-priced sheets in 1898 were made from sheet bars costing not much if anything above $15 a ton, while the recent low-priced sheets were made from sheet bars costing $19 to $20. It is insisted in the trade that the recent business was conducted at an absolute loss and the question asked has been how long the surplus being drawn upon would last. After the period of lowest prices there was, in December, a sharp but very moderate advance, and it is questionable whether even the closing prices of the year avoid loss to mills which must buy sheet bars, particularly as in sheet bars also there has been an advance.

The average openly quoted prices on sheets and tin plates during the year, compared with the average of the preceding year, were as follows:

Months.	Black sheets, No. 28. Cents per lb.	Galvanized sheets, No. 28. Cents per lb.	Tin plates, per 100-lb. box.
January	2.20	3.20	$3.60
February	2.20	3.20	3.69
March	2.20	3.20	3.70
April	2.20	3.20	3.70
May	2.20	3.20	3.70
June	2.00	3.00	3.70
July	2.00	3.00	3.70
August	1.91	2.93	3.64
September	1.90	2.90	3.60
October	1.85	2.87	3.49
November	1.84	2.84	3.40
December	1.85	2.85	3.40
Year 1911	2.03	3.03	$3.61
Year 1910	2.29	3.37	3.60

Course of the Market

The year opened with the market quite firm. There had been irregularities in sheets, the market having definitely dropped below the so-called "official" prices of 2.20 cents for black and 3.20 cents for galvanized, but these irregularities had disappeared. A general improvement in the tone of the finished steel market occurred early in the year.

Pig tin, which closed at 30.50 cents November 12, 1909, the day on which tin plates were advanced from $3.50 to $3.60, stood at an average price of 34.27 cents in 1910, and an average of 38.28 cents in December, 1910. On January 30, 1911, it closed at 44.50 cents, and on the strength of this advance an informal conference of tin plate manufacturers held February 3 in Pittsburgh concluded that the price of tin plate should be 10 cents higher, or $3.70. Pig tin did not advance further for some time, averaging between 42 and 43 cents from January 1 to August 1, but the tin plate price held fairly well until August, when an irregular decline to $3.60 occurred. Additional shading took place in October, and on October 16 the American Sheet & Tin Plate Company announced a price of $3.40 for the coming season. This price was

shaded in the case of very large contracts, by 10 to 15 cents per box, but was maintained upon small lots. Previous season prices had been subject to a little shading in the case of very large contracts, but the trading in tin plate in this case was freer and partook more of the nature of negotiation, being in harmony with the fact that an open market then prevailed on all finished steel products.

In the finished steel trade as a whole an open market is held to have arrived in the summer, being brought about by various influences, including the taking of an independent attitude in steel bars by one of the large producers, but in the sheet trade practically open market conditions obtained at an earlier time, a fact evidenced by the drastic reduction of $4 a ton made in its official price May 29 by the American Sheet & Tin Plate Company. This put black sheets on the basis of 2 cents, galvanized at 3 cents and blue annealed sheets at 1.50 cents. Soon these prices began to be shaded, at first quietly and then openly.

Spelter and Galvanized Sheets

The pressure upon the galvanized sheet manufacturers was particularly severe in the closing months of the year. During 1910 the spread between black and galvanized sheets, No. 28, averaged $1.08 per 100 lb., the average price of spelter, East St. Louis, being 5.42 cents. This was practically in keeping with the experience of the past few years, a general comparison of prices indicating that a spread of $1 between black and galvanized corresponds with a 5-cent spelter price, while the spread should advance about 5 cents per 100 lb. for every 0.40 cent advance in spelter.

At the opening of 1911, however, the spread between black and galvanized sheets, No. 28, was only $1 per 100 lb., and it did not rule materially above that amount at any time in the year. The price of spelter, however, advanced. It averaged 5.35 cents in January, but reached 6 cents by the middle of August, and by the close of November it had reached 6.85 cents, the average for the four months, August to November, inclusive, being 6.07 cents, a price which should have indicated a spread of $1.10 or $1.15 between black and galvanized sheets.

It is true that advances in spelter do not bear so heavily on the thicker gauges as they do on No. 28. An advance of one cent a lb. in spelter increases the cost of making 100 lb. of No. 28 galvanized sheets between 15 and 20 cents, but of No. 22 only one-half as much and No. 10 only about one-eighth as much. The custom in the trade is to quote galvanized sheets on the basis of No. 28, observing certain spreads between gauges, which vary only at rare intervals. This perhaps is a survival of the principle involved in the old system of having list prices on galvanized sheets for the different gauges, and quoting a discount from list. The observance of a regular spread in the black sheet list introduces no great inconvenience, but in the case of galvanized there should be more flexibility, and it is particularly unfortunate for the selling trade that the gauge upon which prices are customarily quoted is the gauge (outside of No. 29, rarely used) upon which advances in spelter bear most heavily.

The Production of Sheets and Tin Plates

A year ago, in reviewing the sheet and tin plate trades for 1910, the forecast was made that the production of sheets in the year would be shown by the official statistics to be about 1,400,000 gross tons of black sheets, No. 13 and lighter, and about 700,000 gross tons of black plates for tinning. The official statistics, published several months later, well confirmed the forecast, showing a total output of 2,147,756 tons, of which 712,136 tons was black plates for tinning, leaving 1,435,620 tons as the product of ordinary sheets. The forecasts were "out" by 1½ per cent. in the case of black plates and 2½ per cent. in the case of sheets.

On account of the uncertain manner in which the mills were operated during 1911, no similar forecasts are ventured at this time. The 1910 outputs were records by large margins, and the records were probably broken in 1911, but not by large margins. Even to maintain the 1910 rates of production, however, would be doing very well, for the output of pig iron in 1911 has been about 13 per cent. less than that in 1910, indicating that steel products in general decreased very materially in tonnage, and for the sheet and tin plate tonnages to hold their own would be indicating a great deal of vitality.

The Number of Mills

Only a few sheet mills were built in 1911. The most important addition to the independent list was that of the American Rolling Mill Company's new plant near Middletown, Ohio, this plant comprising 10 mills, the company having had 4 mills in its original Middletown plant, with 6 mills in its Zanesville plant.

Eliminating several small plants, long inoperative, the number of independent sheet mills, regularly operative, was 264 at the close of 1911, controlled by 33 interests. This summary includes sheet mills, jobbing mills, and mills operated "tin mill style" without tinhouse accompaniment.

The American Sheet & Tin Plate Company completed its new plant at Gary, Ind., this comprising 16 sheet, 4 jobbing and 2 light plate mills. Adding the 20 sheet and jobbing mills to its former list gives this interest a total of 204 sheet and jobbing mills. Its chief new work at the present time is the rearrangement of the Mercer Works, at Sharon, Pa. The Bray semi-continuous mill in that plant will be dismantled and the plant will be operated as a specialty mill.

There is no large amount of new construction in the independent sheet trade at present, but an addition of 3 mills is to be made to the plant of the West Penn Steel Company, Brackenridge, Pa., making this a 10-mill plant.

In tin plates the American Sheet & Tin Plate Company made no additions in 1911, its list remaining at 235 mills. While these are officially classed as tin plate mills the plant at Cambridge, Ohio, containing 7 mills, has no tinhouse.

Among the independents, the Jones & Laughlin Steel Company added 12 tin mills at its Aliquippa plant, making the total at this plant 24, and 4 of the new mills were started late in December, with the others to follow early in January. The Washington Tin Plate Company, Washington, Pa., completed the rebuilding of its plant, increasing it from 5 to 6 mills. These changes bring the total number of regularly operative independent tin plate mills up to 145, this summary not including two small plants, Avonmore, Pa., and Greencastle, Ind., long inoperative.

The Cincinnati Iron Trade in 1911

BY CHARLES L. SMITH

With the machine tool builders in this section the first half of 1911 was reasonably good, so far as the domestic trade was concerned, but, with the exception of December, the last half of the year did not show up so well. However, the total for the entire 12 months is approximately the same as for 1910. Export orders assisted materially in swelling this general average, and business from this particular source will probably be even better in 1912, as manufacturers are more and more realizing its importance.

The delayed buying on the part of the railroads, that had its start in December, has done much toward promoting a more optimistic feeling in all business lines. This movement has not yet had any appreciable effect in the demand for machine tools, but the general opinion is that the urgent need for new shop equipment will bring out a much larger volume of orders some time soon.

As far as the foundries are concerned, not including the stove makers, a fair estimate of their activity would be 25 to 30 per cent. below 1910. Jobbing foundry contract prices were also not very satisfactory, but there is now a tendency on the part of foundrymen to hold out for fairer figures, as no small percentage of orders was taken last year at cost, and in many cases the foundries sustained an actual loss in the ultimate cost of castings poured.

From a tonnage standpoint only, the pig iron business for 1911 was fairly satisfactory, but the low prices prevailing throughout the year were extremely disappointing. A year ago at this time the price of Southern iron, based on No. 2 foundry, was $11, Birmingham, for spot or first quarter shipment; to-day the price is $10, with a number of producers willing to book first half business on this basis. The reduction in both furnace and yard stocks, together with activity in railroad circles, already alluded to, would certainly indicate that the present low prices will be minimum for 1912, and it is not unreasonable to look for an improvement before the end of the first quarter.

Northern iron was inactive nearly the entire 12 months of 1911, with occasional sales reported of fair-sized blocks of steel making iron to relieve the monotony. Malleable iron had several periods of activity, but the usual advance of about 25 cents a ton over No. 2 foundry was not generally observed, and it is quotable to-day at $13, Ironton, which is the prevailing price for No. 2 foundry for any delivery up to July 1.

Review of the First Six Months

As is usual after a holiday period, when buying has been postponed, the first two weeks of January brought out a large number of inquiries for small lots of foundry iron. During the latter part of the month deliveries were extended and business for first half shipment was taken at $11, Birmingham, for Southern No. 2 foundry and at $14, Ironton, for Northern foundry. Some interest was shown in furnace coke.

About the middle of February there was considerable activity in foundry iron; two large lots of basic also changed hands, and while there was an effort to advance prices it was not successful. The opening of order books for third and fourth quarter delivery brought out a large number of inquiries in the fore part of March, and some Southern iron was taken around $11.50 for last half shipment. Business slumped off during the latter part of the month, and several Southern producers made quotations on last half business as low as $11, Birmingham.

The market was very erratic during April and May. The first 10 days in April gave promise of better conditions, and there was considerable buying, but for the remainder of that month business was exceedingly dull. A reduction of 50 cents a ton in Southern prices brought out some latent buying about the middle of May. Northern iron producers attempted to hold prices firm, but were compelled to make reductions in order to meet Southern competition.

Review of the Last Six Months

Although the first week of June made a fairly good showing, Southern and Northern prices were respectively reduced to $10.50, Birmingham, and $13.50, Ironton, and after a little spasmodic buying early in July conditions settled down until the published statistics in August caused a firmer feeling on the price question, but brought out little new business. Early in September Southern iron went to $10, Birmingham, and for prompt shipment there were rumors that even this figure was cut. With the exception of heavy buying by pipe makers, October was a featureless month, and the market dragged along until a reduction in Southern prices to $9.75, Birmingham, the latter part of November brought on a considerable buying movement that extended through nearly all of December. The second week in December showed Southern iron back to $10, Birmingham, with producers generally refusing to cut this price even for immediate shipment.

The old material dealers have had a comparatively lean year, but they are entering the present year with a much more optimistic feeling generally prevailing among them than at the same time in 1911.

Following are average monthly prices f.o.b. Cincinnati, for Southern and Northern foundry pig iron and leading grades of scrap, all prices being per ton of 2240 lb. except railroad wrought and cast scrap, which are per ton of 2000 lb.:

	Southern No. 2.	Northern No. 2.	No. 1 railroad wrought.	No. 1 cast scrap.	Heavy melting steel.
January	$14.25	$15.20	$12.00	$11.00	$11.56
February	14.25	15.20	12.00	11.00	11.06
March	14.25	15.20	12.00	11.00	11.00
April	14.25	15.20	11.50	10.25	10.25
May	14.00	15.14	11.50	9.75	10.00
June	13.50	14.50	11.50	9.60	10.00
July	13.25	14.20	11.50	9.50	10.00
August	13.45	14.20	10.95	9.95	10.45
September	13.31	14.20	10.69	9.75	10.25
October	13.25	14.20	10.50	9.75	10.25
November	13.20	14.20	10.25	10.05	10.00
December	13.19	14.20	10.44	10.31	10.00
Average	13.68	14.64	11.23½	10.16	10.40

Lake Superior Ore Developments

Review of the Trade of 1911—More Ore Deposits Being Found—Works for Beneficiating Raw Iron Ores

BY D. E. WOODBRIDGE

Since the beginning of its development, in 1855, the Lake Superior iron ore region has produced 525,000,000 tons of ore, all but a very small fraction of which has been shipped to Eastern points of reduction. The 10 years closing with 1911 have seen the delivery of 65.4 per cent. of this vast amount. Of all of it the Mesaba range has mined nearly one-half and is now annually called upon for 65 to 70 per cent. of all Lake ore that is consumed.

At the date of writing this review the production for the past year cannot be stated with entire accuracy; there will be some all-rail shipments and a few of the railroads have not given their precise totals. But the following figures are substantially correct:

Production of Lake Superior Ore, Gross Tons.

	1911.	1910.
Superior (two railroads)	9,935,000	8,437,261
Duluth	6,934,269	13,609,155
Two Harbors	6,417,523	8,286,545
Escanaba (two railroads)	4,278,445	4,959,869
Ashland (two railroads)	2,429,290	4,093,822
Marquette (two railroads)	2,200,280	3,248,930
Michipicoten	130,000	115,700
Key Harbor	6,645	.....
Total	32,881,552	43,568,582

Shipments from Baraboo and Mayville, Wis., have never been included in Lake Superior totals, though they come in direct competition. Baraboo shipped no ore during the year past, and Mayville the customary small amount.

All rail shipments are to furnaces at nearby points in Minnesota, Wisconsin and the upper and lower peninsulas of Michigan. These will probably not increase materially until the completion of the new works of the Minnesota Steel Company at Duluth, which will use about as much as the entire rail shipments of the present.

How the Great Northern Lease Diverted Business

Shipments from the port of Superior have, for the first time, exceeded those of any other point. This is due to the provision of the United States Steel Corporation's lease on Great Northern Railway lands requiring that all ore mined on those lands shall be shipped over that road. Its docks are at Superior. To the Superior total is also added about 140,000 tons from the new Cuyuna range, which made its initial shipments the past year. As showing how the Great Northern lease has worked out in diverting business from all other Oliver Iron Mining Company lands to those held under this lease the full figures of shipments of this company are given herewith with comparisons with the previous year. In 1910 the shipments under this lease were about 4 per cent. of the total tonnage forwarded from the Lake region, while in 1911 they were almost 18 per cent.

Oliver Iron Mining Company Shipments, by Mines, Gross Tons.

	1911.	1910.
Menominee range:		
Aragon	201,269	241,046
Chapin	357,598	465,543
Iron Ridge	17,144	.....
Mansfield	54,646	114,357
Riverton	200,142	84,369
Total Menominee	830,799	937,624

Gogebic range:		
Norrie Aurora group	883,910	1,333,006
Tilden	138,387	99,937
Total Gogebic	1,022,297	1,563,564
Marquette range:		
Lake Superior	174,874	271,445
Queen group	297,675	230,119
Stegmiller	45,122	48,842
Total Marquette	517,671	752,381
Vermillion range:		
Pioneer	401,430	526,435
Savoy	87,964	59,875
Sibley	1,899	206,386
Soudan	65,350	75,511
Zenith	449,727	283,320
Total Vermillion	1,006,370	1,151,707
Mesaba range:		
Burt	157,299	1,032,815
Dale	1,004,848	.....
Harold	281,943	27,711
Hull-Rust	496,977	3,189,975
Mace	125,013	15,267
Mississippi	329,032	36,581
Morris	40,481	1,364,673
Penobscot	189	.....
Sellers	87,324	954,042
North Uno	479,605 }	
South Uno	266,399 }	341,939
Winnifred	52,414	67,686
Clark	503,597	529,222
Chisholm	724,798	634,236
Glen	196,231	286,051
Leonard	1,298,170	987,910
Myers	93,203	131,440
Cavour	1,104	.....
Adams	411,749	1,258,295
Spruce	638,773	613,947
Minnewas	295	963
Fayal	443,804	1,485,099
Genoa	924,454	283,299
Higgins	250	151,854
Sauntry-Alpena	1,057,839	242,373
Virginia group	649,675	985,163
Canisteo-Walker-Fay	1,343,064	1,105,160
Holman-North Star	780,665	413,873
Hill	1,553,510	801,088
Oliver Company, Total Mesaba	13,342,696	17,257,533
Total, all ranges	17,319,833	21,662,809

The figures for 1910 include several mines that were entirely idle during 1911 and that do not appear in the tables.

Abrogation of Great Northern Lease and Freight Reduction

During the year the Great Northern lease was abrogated, as of January 1, 1915, and Minnesota iron ore freights from the mines to Lake Superior were reduced from 60 cents, 90 cents and $1 to a flat rate of 60 cents a ton. These two changes, while affording ample scope for speculation and comment, were not unexpected events, and will have little bearing on the general trade. The abrogation of the lease will mean record-breaking shipments for the coming three years over the Great Northern road in the desire of the Steel Corporation to take out all the ore it must pay for under the agreement as to minimums, and that it is practically assured that these minimums are to be taken is shown by the fact that a very slight acceleration of production on the leased lands for the period will care for all minimums therefrom.

Reduction of freights means a correspondingly lessened cost of ore that will assist either the miner, the manufacturer or the consumer, or all of them. Miners are hoping to receive the benefit, but they cannot expect more than a fraction of it, and if the results of previous savings are any guide to the future these savings will go chiefly to the manufacturer and consumer. If to the latter they will mean about two-one hundredths of a cent per lb. of finished steel, truly not very much.

No New Mesaba Discoveries

The Mesaba, on account of its geological pecularities, was a region especially adapted for rapid and easy discovery of ore, and for quick development. Therefore it was not long before the bulk of its tonnage was known. Today it is far from the most encouraging field for exploration; other districts, known many years longer, and for most of the period of their existence the scenes of active search for ore bodies, are now much more favored by explorers. During the year just passed Mesaba finds have been few and unimportant. Most of what ore has been added to its reserves has been in the extension of already found deposits, and it may be doubted if, when one regards the diminishment of tonnage by the limitation of ore bodies caused by the more careful and thorough exploration that has been carried out on known deposits during the year, there has been any addition to former reserves in this district.

Elsewhere the contrary has been true. While there has been considerable exploration in all Lake fields, the chief results have been in parts of the Menominee range and in the Cuyuna district. The briskness of exploratory operations in the face of a dead ore market has been rather remarkable, and is one indication that iron ore people look ahead further than most of them did in times past. Extensive tracts of land on both the Marquette and Menominee ranges, owned by the Michigan Land & Iron Company, are held under option by the Oliver Iron Mining Company, and exploration has started by diamond drilling. Most of this work is being done in Iron County.

New Mines on the Menominee Range

In the Crystal Falls district M. A. Hanna & Co. have opened large mines at the Monongahela and Ravenna. Close to Crystal Falls the Breitung interests have started extensive operations; near Amasa several companies are at work. Perhaps the most important find of the year in that region is the Monongahela, section 36-43-33. Here what seems to promise a very large tonnage of ore running about 55 per cent. has been found and is now under development. In connection with Ravenna, close by, this will be one of the most important mines operated by the Hanna interests. The Wickwire Steel Company has taken several options on the Menominee range during the year, among them the Pucell tract, adjoining James and Davidson (two good new mines), a tract between Sheridan and Hiawatha mine, a third in section 33-43-35, and still others, on all of which exploration has begun.

Many drills are employed about the Menominee for the above and other interests, and it is probable that the new year will record a number of additional deposits. Indeed, it is now true of that district, as of the Marquette and Gogebic, that more ore is in sight than at any time in history, and that the outlook for still more is better than it has been.

New Ore Deposits on the Marquette Range

In the Negaunee field of the Marquette range exploration is steadily enlarging the tonnages known. Directly west of Ishpeming two large mines, recently found by drilling, are being developed, and other probable deposits are under systematic exploration. In the Champion, Humboldt, Michigamme and Republic fields of that range there is much of promise, and there is no little activity there in the search for deposits of ore, some of which is being rewarded. At and in the vicinity of American mine, of M. A. Hanna & Co., not only are they finding important properties, but others are doing the same. Hanna & Co. have many hundred acres there of favorable ground. The Mineral Lands Company is to sink a concrete shaft west of American mine, in ground that has been proved, and where the deepest diamond drill hole in the country was put down some time ago—to the depth of 3200 ft. The Cleveland-Cliffs Iron Company is preparing to mine in quantity from its new Morris and Lloyd mines, four miles west of Ishpeming, where a very large deposit has been opened. Ore shipments began the past year from Lloyd. The company has installed a fine mine plant and the residence location is planned on broad and admirable lines. The same company is developing its Barnes property, near Dexter mine, where it has another new mine. A few miles southwest from Republic, where deep drilling has been carried on at various times in past years, the 46-30 Mineral Land Company has begun work under favorable auspices. The Breitung-Kaufman and Cleveland-Cliffs interests have segregated their joint holdings in Negaunee and the two companies that result therefrom are preparing to explore actively.

In the Cascade district extensive exploration has been started on lands in section 26-47-20. This is near Volunteer mine, where a large deposit of high grade Bessemer ore has been located by drilling that has been under way for a year or two.

On the Gogebic range several new mines are in course of development, and the possibilities are expanding. Some miles east of the Newport mine the Newport Company, in its Anvil mine, has added to reserves what seems a large and high grade discovery. East of Anvil Yale mine is opening a newly discovered deposit at the depth of

1800 ft. Tilden mine, at Bessemer, is said to have found large new ore bodies at depth that make it a big property once more.

The Cuyuna Range

In the past year the first shipments of iron ore from the Cuyuna range in Minnesota have been made. The total amount moved was 147,000 tons, taken from the Kennedy mine of the Rogers-Brown Ore Company and shipped over the new branch of the Soo Line to the new ore docks of that road at Superior, Wis. The ore shipped was representative of the average product that may be expected to come from this district in the next few years, although an important portion of the tonnage so far proved up will run considerably higher in iron content. The shipments of the past year averaged between 45 and 46 per cent. metallic iron, natural, and in other constituents and characteristics the ore was decidedly desirable. The plans for shipments next year contemplate the movement of 200,000 tons from the Kennedy mine, 100,000 tons from the Armour mine owned by the Iroquois Iron Company, and a like amount from the Thompson mine of the Inland Steel Company. This iron is expected to grade from 46 per cent. in iron, natural, up to 51 per cent.

As has been previously explained, the iron formation of this district embraces two ranges, known as the North and the South. While the Adams syndicate is now actively engaged in sinking a concrete shaft on the South range, at a property drilled and abandoned by the Rogers-Brown Ore Company, and M. A. Hanna & Co. are exploring a property southwest of Brainard, the major portion of the year's development has been confined to the North range. In addition to the operation of its Kennedy mine, the Rogers-Brown Ore Company put down a concrete shaft on its Meacham property. After the sinking of the shaft, development work on this property was discontinued pending an improvement in the condition of the ore market. This company is also conducting the development work of the Armour mine mentioned above. On the forty adjoining that of the Armour deposit, the Inland Steel Company has put down a concrete shaft and more recently Oglebay, Norton & Co., Cleveland, have taken over a proved deposit from the C. M. Hill Lumber Company and are now checking the drill holes preparatory to putting down a shaft.

Conditions thus far encountered have made it advisable hereafter to build shafts of concrete, which work has been done by the Foundation Company of New York. The development work of the year has served to establish somewhat more clearly the character of the Cuyuna ore-bearing formation. The feeling has existed in the past that drilling for ore in this field was largely a hit or miss proposition. This is still true to a degree, because of the peculiar interruptions of the continuity of the ore lenses. The general trend of the North range has been followed as far as the Mississippi River. It is not continuous, however, but consists of parallel lenses of irregular location and extent. The ore formation stands at an angle of from 50 to 70 degrees and the ore bodies, although they may easily be missed by drill, admit of opening up and working to advantage.

Conditions on the Vermillion Range

Explorations have continued on the Vermillion range with less fervor than a year ago, the pace proving too hot for many of those interested. Prospects are for the development of a few minable ore bodies as the result of explorations that have been under way for some time. Shafts are being sunk on section 30-63-11; on 25-63-12; at the Vermillion & Mesaba Iron Company's property in sections 4 and 5, 62-12; at the Almar, in 15-62-14; the North American, section 4-61-15; the Cannon, section 2, same township; the Pine Island, section 5-62-15, and the Vermillion Iron & Steel, section 5-62-14.

The number of shippers from the range has been increased by the addition of two, a notable fact, for in the past there has been no shipping company but was subordinate to the Steel Corporation. These two are the Section 30 Company, which forwarded 34,000 tons, and the rejuvenated Chandler, which sent down 50,000 tons.

Improvements in Mine Equipment

The sinking of steel and concrete shafts, the erection of more permanent and complete mining plants and the substitution of hydroelectric for steam power have all gone on rapidly during the year. In some districts the wood shafthouse, formerly the only form of headframe, is now a thing of the past; there is scarcely one of the type left on the Marquette or Gogebic range. An 8000-hp. water power development is under construction by the Cleveland-Cliffs Company on Carp River, near Marquette, for delivering power to all its mines in that region. This company is the chief mine operator on the Marquette range. There will be some 40 miles of transmission lines.

Large sums have been spent the past year in the inauguration of mine safety appliances, devices and methods. The Oliver Iron Mining Company has been prominent in this work, together with the Cleveland-Cliffs Company, Pickands, Mather & Co., M. A. Hanna & Co. and other leading shippers, and they have formulated rules under which all work at mines and in mining plants and shops is to be carried. These have already resulted in important savings of life and limb. The importance of this work being seen, it will spread to all parts of the mining region.

Plants for Dressing Ore

Including the works recently built and in operation and those now under construction these plants for the dressing of iron ores are located at Lake Superior mines:

Sand washeries for the Oliver Iron Mining Company and the International Harvester Company, at Coleraine and Nashwauk, Mesaba range.

Drying plants for the Hollister and Brunt mines, of the Crystal Falls district and at Mountain Iron, Mesaba range.

Crushers for hard ores, at Biwabik, Escanaba and elsewhere.

Roasting works for the Magpie and Atikokan mines, at Magpie, Michipicoten range, and at Port Arthur, Ontario.

Pyrite washery for the Helen mine, Michipicoten range.

Magnetic concentrator and briquetting works for the Moose Mountain mines, at Sellwood, Ontario.

Nodulizing plant for the Kloman mine, at Republic, Marquette range.

Sizing and briquetting plant at the Northwestern Iron Company's mine, Mayville, Wis.

The Lake region has never seen the crystallization of such a movement for the practical conservation of its ores by beneficiation, nor is the significance of this movement generally understood. However interesting and important may have been other features of the year, there is none that begins to equal this in its bearing on the future and its interest for the present.

The Warren Tool & Forge Company

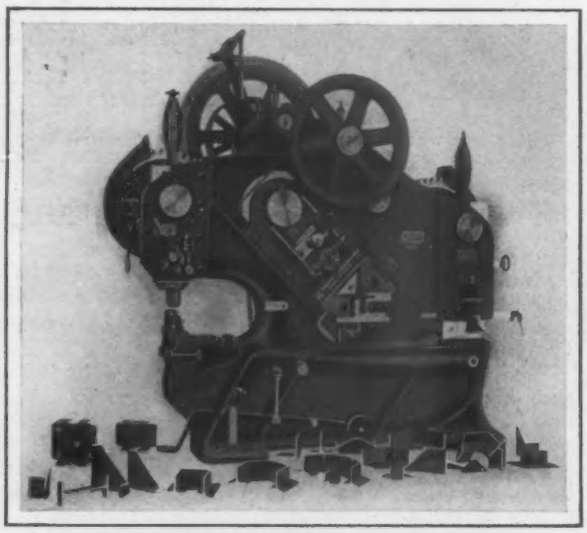
This company, recently granted an Ohio charter with a capital stock of $100,000, is building a plant on a 10 acre site at Warren, Ohio, having connections with the Pennsylvania and Erie railroads. A contract has been placed with the Pittsburgh Bridge & Iron Works, Rochester, Pa., for a main building, of steel, 75 x 225 ft., which will contain hammers, presses, etc. A warehouse of concrete construction about 50 x 75 ft., and a wooden building, 30 x 50 ft. for storage, will also be erected. Power will be furnished by the Trumbull Public Service Corporation. The equipment will be of the latest type and the products will be picks, mattocks, crow bars, wedges and other track tools, blacksmith vises, etc. It is expected that the plant will be ready for operation about March 1. James D. Robertson is president; George F. Konold, for over 20 years superintendent of the Iron City Tool Works, Ltd., Pittsburgh, is vice-president and general manager; M. J. Konold, an experienced forge man, is secretary and treasurer and will have charge of sales, with an office in the Bessemer Building, Pittsburgh. The question of branch offices in Eastern and Western cities is being considered.

The Precision Instrument Company, manufacturer of measuring and regulating instruments, Detroit, Mich., has increased its capital stock from $24,000 to $48,000 for the purpose of adding to its working capital to take care of its increasing business and also to provide for placing on the market several new inventions for steam and gas plants which will be put on the market in the near future.

New Shearing Machine

A new type of cast-steel shearing machine, combined with sectional bar cropper and punch, has been recently put on the market by the Schatz Mfg. Company, Poughkeepsie, N. Y., and 138 Liberty street, New York City. This machine has been designated by the maker as its No. 246-D shearing machine combined with sectional bar cropper and punch and embodies a number of improvements in its construction over the No. 246-B combination shearing and punching machine which was illustrated in *The Iron Age* April 6, 1911. The principal change has been the placing of the sectional bar cropper slide at an angle of 45 deg. instead of in the vertical position, as was the case with the older machine. The special advantage of this arrangement is that structural shapes which are to be cut on a mitre are inserted in a horizontal position, the same as if they were to be cut square, and it is emphasized that this enables a cut to be made at right angles or on a mitre through the middle of the longest bar.

This type of machine is built in eight sizes and is designed to meet all the requirements of users of punching and shearing machinery as the smallest one will cut channels and I-beams up to 3 in., the largest up to 24 in. and plates from 7/16 to 1¾ in. thick. In this system of punching and shearing a complete equipment contained in one construction with one drive is secured which can cut and



The New No. 246-D Shearing Machine Combined with Bar Cropper and Punch built by the Schatz Mfg. Company, Poughkeepsie, N. Y.

punch sheets, plates, flat bars and all types of structural shapes in any required manner and especially mitre I-beams and channels. Each of the three machines can be operated either separately or simultaneously, and special emphasis is laid upon the fact that in the latter case the operators do not interfere with each other.

The punch has a universal punching table consisting of a vertical and a horizontal jaw which is especially suitable for construction purposes. The latter is used principally when it is necessary to punch holes in the flanges of I-beams and channels close to the corner, while the former is used for all ordinary work. The punch is brought into engagement either by a foot trip or a hand lever, the latter being a great advantage when punching along the edge of wide plates, since at such times it is difficult for the operator to reach the trip with his foot. Another special feature in connection with the punch is the locating lever for finding previously marked holes. This device has been employed instead of the old type of hand wheel and is brought forward so that the punch rests on the material and remains there until the hole has been punched. The lever is then returned to its highest position by a spring so that it is ready for the next operation. This arrangement, it is pointed out, is more rapid than the hand wheel system and, at the same time, better control of the punch is secured.

The equipment of the punching machine includes a stripping-off device, which is circular in shape and open on one side so that the punch is always visible to the operator. This stripper is hung in a circular bearing and can be rotated in any desired direction. The material is held down and stripped off horizontally, thus preventing the punch from breaking while the material is being stripped. Vertical adjustment to accommodate the stripper to different thicknesses of material is furnished. Instead of a set screw a key is employed to hold the punch in position.

The plate shear will cut plates of any length or width, and is equipped with an automatic separating device which keeps the cut portion of the plate from binding against the blades or frame of the machine while the cut is being taken. An adjustable arm with an indicator in front of the shearing blade is a unique and convenient feature in connection with the plate shear, and its use enables a plate which has been previously marked or cut to be set exactly to match the line of cut desired, so that a neat and straight cut through the whole plate is insured. When not in use the indicator can be turned up out of the way and does not interfere with the operation of the shear. The hold down device of the shear consists of an adjustable screw spindle operated by a hand wheel with a shoe at the bottom. This shoe is elongated and can be moved in either direction, thus permitting short pieces to be cut and at the same time preventing the jamming of the metal while it is being cut.

The sectional bar cropper or beam shear which is shown in the center of the machine is regularly furnished with blades for cutting angles and tees and round and square bars at right angles together with a mitre attachment to be used in connection with the blades for cutting angles and tees on either right or left mitres from 45 to 90 deg. Blades can also be furnished for cutting channels and I-beams and other structural shapes at right angles without waste. Blades can also be furnished for cutting channels and I-beams on a mitre through the flanges or through the web. The blades in the larger sizes of machines are made from special open-hearth steel with hardened tool steel cutting faces inserted therein In this way the faces can be easily renewed when the blades become dull or worn, thus making the replacement of the blades for large shapes only nominal.

A universal coping fixture is illustrated on the punch end of the machine which is also arranged for electric drive. This coping fixture is fastened to the punching machine and is designed principally for coping, notching and mitering the flanges of I-beams, channels, angles and tees and for coping the webs of the different shapes after the flanges have been coped. It is made in one piece and is bolted at the back and the front of the punching table, thus making it practically part of the machine frame. Samples of the various cuts made by this machine are shown on the foreground of the accompanying engraving.

All gears are cut from the solid, with very wide faces to insure perfect alignment and noiseless operation.

Safety Limit Stop for Electric Cranes

Those experienced in electric hoist or crane service say that with the ordinary limit switch which merely cuts off the current from the motor the stopping point varies considerably. If the limit is set low enough to prevent dangerous over-travel of the hoist block when the hook is light and at high speed, a loaded hook coming up at slow speed will stop below the desired point. The drift of the motor and hook depends on the square of the hoisting speed and the load on the crane hook. Adjustment which suits one condition does not, it is emphasized, provide for all.

In conjunction with L. R. Palmer, safety engineer for the Jones & Laughlin Steel Company, the Cutler-Hammer Mfg. Company, Milwaukee, has developed the new Palmer safety limit stop. This crane limit switch is designed to bring the hoist block to rest within 2 in. of any desired point regardless of whether the hook is lightly or heavily loaded or whether the speed is high or low. The safety stop is not geared to the hoist nor operated by a traveling nut but is operated by a trip rope. The motor circuit is opened and the series field connected across the armature when the hoist block reaches a predetermined point. The dynamic braking action brings the block to rest promptly. The device is inclosed in a substantial case and is made in capacities up to 25 hp. for 110 volts and up to 50 hp. for 220 or 550 volts.

Mayari Steel: Its Properties and Uses

The New Chrome-Nickel Steel Made by the Pennsylvania and Maryland Steel Companies from Chrome-Nickel Iron Ore

The following account of the development of the new Mayari steel is furnished by the Pennsylvania Steel Company and the Maryland Steel Company, in response to the general letter of *The Iron Age*, referred to elsewhere, inquiring what the steel companies of the United States have done in recent years to improve the quality of their product.

In the beginning of the automobile industry the properties of alloy steels and the wide applications of heat treatment were practically unknown to by far the greater majority of consumers of high grade steels. When manufacturers first put upon the market special alloy steels requiring heat treatment to develop their maximum properties, the consumers were reluctant to adopt them, partly because of uncertainty, but principally on account of the higher price which these materials demanded, in some cases as much as 20c per pound. Frequent breakdowns of cars and short lives of different parts, however, soon reconciled the automobile builder to alloy steels for transmissions, engine parts, axles, frames and other steel parts of the motor car.

Within the last five years all such objections and uncertainties have disappeared and quite the reverse trend is taking place. The use of special steels has grown to such an extent that practically all of the steel entering into higher grade automobiles is made to a particular specification and heat-treated by a prescribed formula. In frequent cases the use of an expensive steel is carried too far, and thousands of dollars are wasted by applying a steel to various parts of a car because it proved to be economical material for some one part. Another tendency on the part of the automobile manufacturers is to use steels higher in alloy content than is necessary for the section into which it is made, thereby obtaining a material difficult to forge and machine, and at a considerably higher price than is necessary for the physical properties obtained.

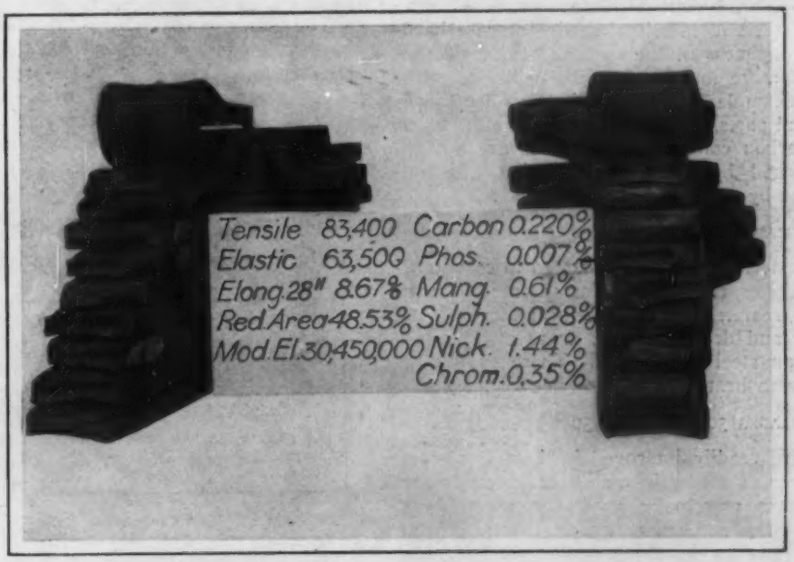


Fig. 1—Fractures and Cold Bend Tests of Mayari Steel Eyebars, Heat-Treated. Grade 20-25. Full-sized Bars.

The Mayari steel herein described is a natural alloy chromie-nickel steel containing sufficient alloy content for practically all commercial purposes. It is made by the Open Hearth process, and the addition of chromium and nickel is unnecessary, because of the fact that these elements are in the ore used and remain in the iron during the steel making processes. By securing these valuable alloying elements in this manner, the steel may be sold at any exceptionally low price, while the quality is sufficiently high to make it applicable to any part of an automobile where alloy steels are now used, or to give increased properties over the carbon steel parts at a price which does not prohibit its use.

Mayari Ore

In *The Iron Age* for August 15, 1907, and April 9, 1908, and in the Bulletin of the American Institute of Mining Engineers for June, 1911, will be found descriptions of the Mayari deposits on the island of Cuba. These contain over 1,000,000,000 tons of ore and are owned in large part by the Spanish-American Iron Company, a subsidiary of the Pennsylvania Steel Company, and it is from this ore that Mayari steel is made.

Properties of the Steel

Mayari steel is made with any percentage of carbon from 0.03 to 1.50. Sulphur and phosphorus are below 0.04 per cent., the phosphorus, however, seldom being found as high as 0.02 per cent. The manganese may be as desired. The nickel varies from 1 to 1.50 per cent., averaging about 1.25 per cent. The chromium content divides the steel into two classes; one contains from 0.20 to 0.40 per cent. chromium and the other has a range of 0.40 to 0.70 per cent.

This steel may be rolled, forged, drop forged or machined, the same as carbon steel, so that drop forging plants or re-rolling mills which handle carbon steel can successfully work on Mayari steel without special precautions, or specially trained men for the heating or handling. In the rolled or forged condition it has from 8000 to 10,000 lb. per sq. in. higher tensile strength and elastic limit than a carbon steel of the same carbon content. Like all alloy steels, it welds with difficulty, but its resistance to welding is not so marked as in those steels containing 1 per cent. or more of chromium or high percentages of nickel. The properties obtained by heat-treating and case hardening this steel will be discussed below.

Grades and Uses of Mayari Steel

For commercial convenience these steels in the lower carbons are divided into eight grades, according to the average carbon and chromium content of each. These grades are 10-25, 10-50, 20-25, 20-50, 30-25, 30-50, 40-25 and 40-50. The first number indicates the average carbon content, and the second the average chromium. Thus, grade 20-25 contains 0.15 to 0.25 per cent. carbon and 0.20 to 0.40 per cent. chromium. Grade 20-50 contains 0.15 to 0.25 per cent. carbon, and 0.40 to 0.70 per cent. chromium. The remaining elements unless otherwise specified are:

Phosphorus and sulphur below	0.04 per cent.
Manganese	0.50 to 0.80 per cent.
Nickel	1.00 to 1.50 per cent.

For higher carbons than given on these grades the composition desired must be specified. The lower chromium grades are recommended where the section treated is comparatively small, approximately 1 to 1½ in. thick. For materials of this section it gives as good results as could be obtained with a steel containing considerably higher

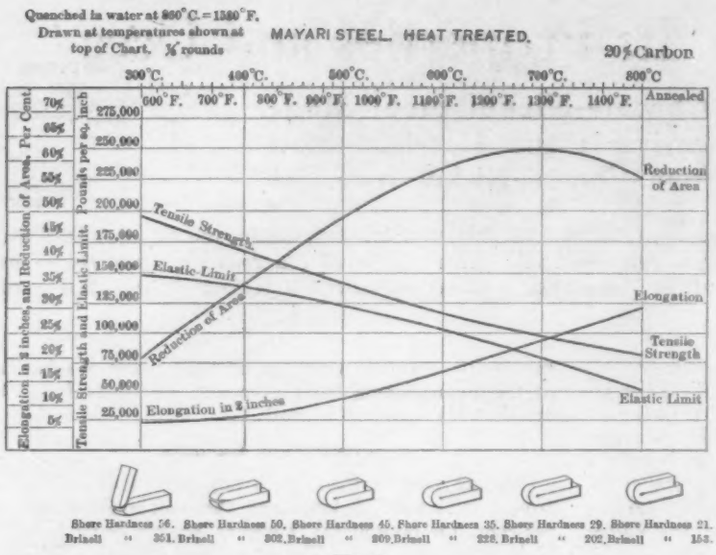

Quenched in water at 860°C.=1580°F.
Drawn at temperatures shown at top of Chart. ¾" rounds
MAYARI STEEL. HEAT TREATED.
20% Carbon
300°C. 400°C. 500°C. 600°C. 700°C. 800°C
600°F. 700°F. 800°F. 900°F. 1000°F. 1100°F. 1200°F. 1300°F. 1400°F.
Annealed
Reduction of Area
Elongation
Tensile Strength
Elastic Limit
Tensile Strength.
Elastic Limit
Reduction of Area
Elongation in 2 inches
Elongation in 2 inches, and Reduction of Area, Per Cent.
Tensile Strength and Elastic Limit. Pounds per sq. inch
Shore Hardness 56. Shore Hardness 50. Shore Hardness 45. Shore Hardness 35. Shore Hardness 29. Shore Hardness 21.
Brinell " 351. Brinell " 302. Brinell " 269. Brinell " 228. Brinell " 202. Brinell " 153.

Fig. 2

alloy contents. For larger sections than the above, the higher chromium grades should be used.

GRADES 10-25 AND 10-50

These are soft steels intended primarily for case hardening, where the toughness of the core and the resistance to abrasion are of more importance than ability to withstand shocks; for example, rivets, gas cylinders, drop forgings, light structural parts, boiler tubes and seamless tubes. Due to the low carbon content, these grades are not appreciably strengthened by heat treatment, but are considerably toughened by this process.

GRADES 20-25 AND 20-50

These are mild steels particularly adapted to case hardening, cold rolled sheets, cold pressed forms, case hardened bearings and races, seamless tubes, structural shapes, bolts, high tensile rivets and drop forgings, or to any purpose where a mild tough steel is required. These grades respond quite readily to heat treatment. (See Fig. 2.)

GRADES 30-25 AND 30-50

These grades are readily improved by heat treatment, giving a high degree of strength, with great ductility and toughness. They are principally used for automobiles, carriage and car axles, gas engine crank shafts, driving shafts, jack shafts, steering knuckles, connecting rods, torsion tubes and a large variety of drop forgings for automobile, or other manufacturing purposes, and for heavy forgings and structural materials. They are, in fact, the most widely used grades, for they combine sufficient strength and at the same time such great toughness that

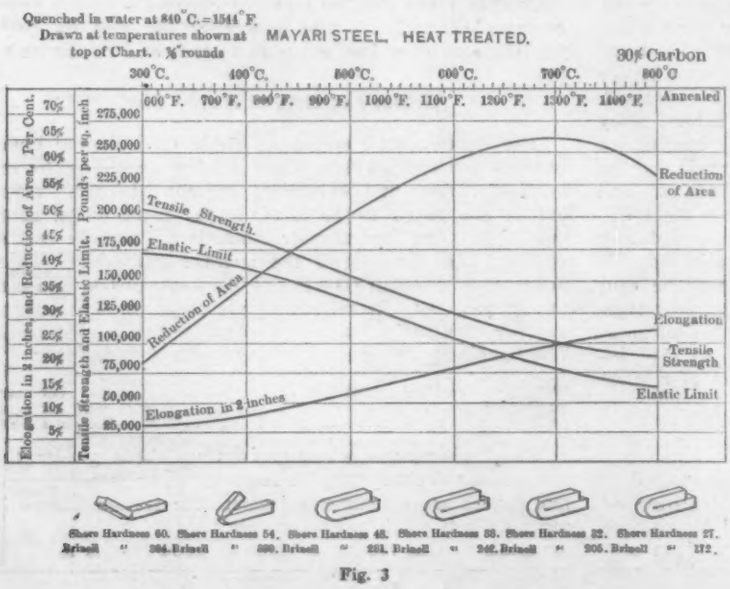

Quenched in water at 840°C.=1544°F.
Drawn at temperatures shown at top of Chart. ¾" rounds
MAYARI STEEL. HEAT TREATED.
30% Carbon
300°C. 400°C. 500°C. 600°C. 700°C. 800°C
600°F. 700°F. 800°F. 900°F. 1000°F. 1100°F. 1200°F. 1300°F. 1400°F.
Annealed
Reduction of Area
Elongation
Tensile Strength
Elastic Limit
Tensile Strength.
Elastic Limit
Reduction of Area
Elongation in 2 inches
Elongation in 2 inches, and Reduction of Area, Per Cent.
Tensile Strength and Elastic Limit. Pounds per sq. inch
Shore Hardness 60. Shore Hardness 54. Shore Hardness 48. Shore Hardness 38. Shore Hardness 32. Shore Hardness 27.
Brinell " 364. Brinell " 330. Brinell " 293. Brinell " 248. Brinell " 205. Brinell " 172.

Fig. 3

they are applicable to a countless number of uses.

The properties developed by heat treatment are shown on the chart in Fig. 3. In Fig. 4 is shown cold bending tests on heat-treated automobile connecting rods made from grade 30-35. These rods have the following properties:

Tensile strength, lb. per sq. in.	120,000
Elastic limit, lb. per sq. in.	100,000
Elongation in 2 in., per cent.	18.00
Reduction of area, per cent.	57.00

GRADES 40-25 AND 40-50

These steels are in the higher carbons and are suitable for heavy work, such as heavy automobile truck axles, locomotive driving axles, water and oil-treated transmission gears, connecting rods, piston rods, crank shafts, driving shafts, automobile steering knuckles, or other automobile parts which are to be subsequently heat-treated. These grades are extensively used for heavy forgings, annealed or heat-treated, and are accepted by the United States Government for high grade Army and Navy forgings in the untreated condition. The properties developed by heat treatment are shown on the chart in Fig. 6.

MISCELLANEOUS GRADES

The above general classification is given principally for automobile construction, and deals almost entirely with the steels entering into the various parts of pleasure cars and industrial trucks. The following specific examples are, therefore, given to show the application of this steel to other purposes, and, while including comparatively few illustrations, they are of such a diverse nature that they will be sufficient to show its wide applications.

Vanadium and Titanium in Mayari Steel

The bases for all of the vanadium steels are either

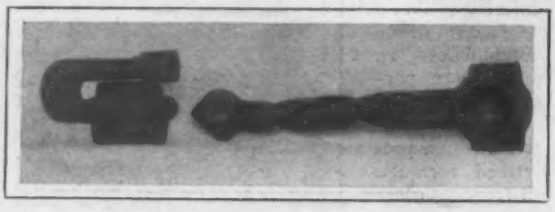


Fig. 4.—Mayari Steel Connecting Rods. Heat Treated. Grade 30-25. Cold Bending Tests.

Tensile strength	120,000 lb. per sq. in.
Elastic limit	100.000 lb. per sq. in.
Elongation in 2 in.	18.0 per cent.
Reduction of area	57.8 per cent.

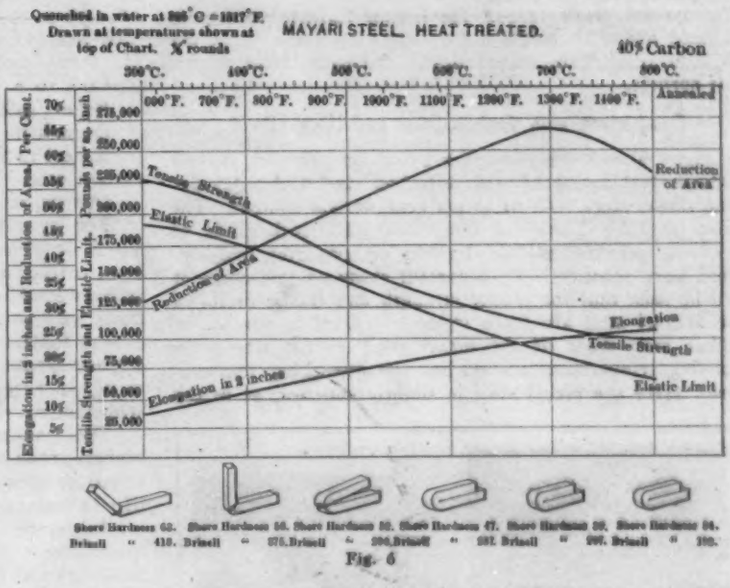
chrome, nickel, or chrome-nickel steels. Mayari steel is, therefore, a natural product into which vanadium may enter as an addition. When this expensive alloy is added to a steel, all factors which might render the heat nonhomogeneous, or otherwise tend to make the steel of an inferior quality, should be removed. Hence having the alloys in the bath during the steel making processes, as in the case of Mayari steel, avoids danger from nonhomogeneity of the chromium content, caused by adding this in the ladle as the heat is tapped, also excessive segregation of other elements, which is often brought about by pouring the steel at too high temperature, in order to have these materials alloy more uniformly. The same holds true for titanium additions, Mayari steel making a uniform and high grade base for this alloy.

Track Bolts

In tightening the bolts in rail joints, it is essential that the pressure applied to the nut does not exceed the elastic limit of the material from which the bolt is made. If it does, the elasticity of the bolt is lost, and instead of holding the splices firmly to the

rail the bolts stretch and allow the joint to work loose in a very short time. The elastic limit of wrought iron and the soft steel which is largely used for this purpose varies from 20,000 to 30,000 lb. per sq. in., while the pressure applied upon the bolt by a workman screwing up the nut with a 3-ft. wrench varies from 15,000 to 40,000 or 50,000 lb. per sq. in., depending upon conditions other than the material from which the bolts are made. In most cases this gives the bolt a permanent set before it has had any service whatever, and the subsequent shocks caused by loads passing over the joints increase this set to such an extent that the joints become loose.

Bolts made from Mayari steel, with rolled or cut threads, show an elastic limit of about 55,000 lb. per sq. in., which is well above the pressure applied by workmen, and are at the same time so tough that they may be bent double, cold, without fracture. It is useless, however, to use this steel for bolts with iron nuts, for the threads on the nuts will shear off and become distorted long before the bolt shows any signs of a permanent set.


Quenched in water at 805°C = 1317°F.
Drawn at temperatures shown at top of Chart. ½" rounds
MAYARI STEEL. HEAT TREATED.
40% Carbon
Tensile Strength
Elastic Limit
Reduction of Area
Elongation
Elongation in 2 inches
Annealed
Reduction of Area
Tensile Strength
Elastic Limit
Shore Hardness 63. Shore Hardness 55. Shore Hardness 32. Shore Hardness 47. Shore Hardness 39. Shore Hardness 24.
Brinell " 410. Brinell " 375. Brinell " 286. Brinell " 237. Brinell " 207. Brinell " 192.
Fig. 6

Eyebars, Heat Treated

Tests made on Mayari steel eyebars, heat-treated, grade 20-25, with the 1,000,000 lb Emery testing machine at the United States Government Arsenal, at Watertown, Mass., show the following:

Tensile strength, lb. per sq. in.	83,400
Elastic limit, lb. per sq. in.	63,500
Elongation in 28-in., per cent	8.67
Reduction of area, per cent	49.53
Modulus of elasticity	30,450,000

The above results are an average of tests on seven bars. These bars bent flat, 180 deg., cold, without sign of fracture. Fig. 1 shows the fractures and cold bent tests of these bars. The size was 1 x 4 x 58 in. between the eyes. The analysis of the steel from which these bars are made is as follows:

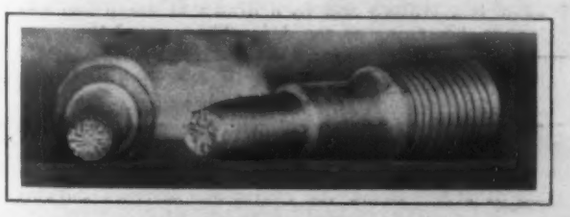


Fig. 5.—"Mitre" Fracture. Tensile Test Specimen Showing Extreme Toughness. Grade 40-50 Mayari Steel. Heat Treated.

Tensile strength	162,500 lb. per sq. in.
Elastic limit	152,000 lb. per sq. in.
Elongation in 2 in.	16.0 per cent.
Reduction of area	56.0 per cent.

	Per Cent.
Carbon	0.220
Phosphorus	0.007
Manganese	0 61
Sulphur	0.028
Nickel	1.44
Chromium	0.35

Mild carbon steel bars, as commonly used in structures, when annealed give the following properties:

Tensile strength, lb. per sq. in.	63,500
Elastic limit, lb. per sq. in.	34,100
Elongation in body of bar, per cent	16.8
Reduction of area, per cent	46.4

The above results are an average of 16 tests on full sized bars.

Rails

A considerable tonnage of both open hearth and Bessemer rails has been made from this steel and the rails placed in service on some of the most prominent railroads in the country. In places where comparisons with other grades of rails could be obtained and in general service they have shown up remarkably well, and up to the present time indications point to a considerably longer life than for the carbon steel rails.

Crank Shafts

The use of Mayari steel for crank shafts was mentioned under the different grades, but it has been so widely adopted for automobiles that the following average results are given to show the physical properties which are obtained by heat treating crank shafts from this material. These results are taken from test pieces cut from the finished shafts after treatment:

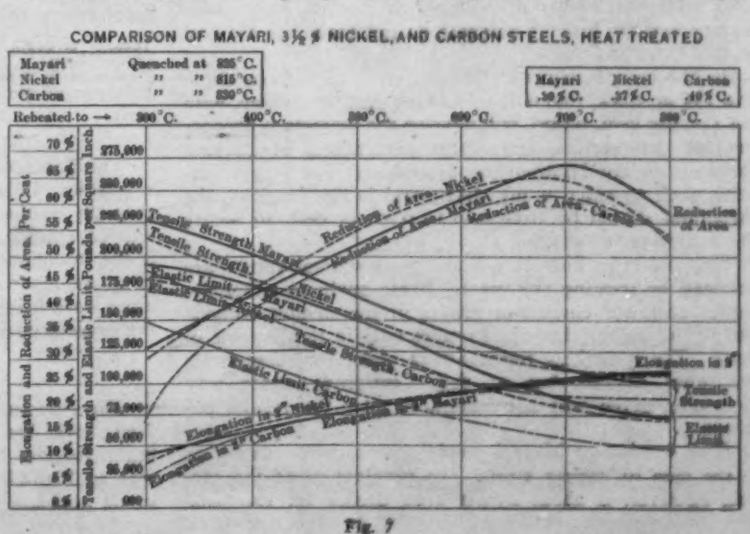
	Tensile Strength.	Elastic Limit.	Elon. in 2 in. Per Cent.	Red. of Area. Per Cent.
2¼-in. diameter shafts	148,300	130,200	15.2	53.7
2-in. diameter shafts	145,500	134,500	15.6	64.0

Pneumatic Chipping Tools, Axes, Etc.

Tools made from Mayari steel at 0.80 per cent. carbon and carefully compared with carbon steels show a 30 per cent. longer life than the carbon steel tools. Hatchets and axes made from 0.50 per cent. carbon grade cut through 1¼ in. of iron bar without losing their edges, and at the same time will bend 90 deg. at the eye without sign of fracture. This steel in various carbons is suitable for cold chisels, punches and other tools requiring hardness and considerable toughness to withstand shocks.

Springs

For leaf spring Mayari steel of 0.90 to 1 per cent. carbon gives about 25 per cent. longer life in "life tests" of full sized springs than the regular carbon steel springs.


COMPARISON OF MAYARI, 3½ % NICKEL, AND CARBON STEELS, HEAT TREATED
Mayari Quenched at 825°C.
Nickel " " 815°C.
Carbon " " 830°C.
Mayari .30% C. Nickel .37% C. Carbon .40% C.
Reheated to →
Tensile Strength, Mayari
Reduction of Area, Nickel
Reduction of Area, Mayari
Reduction of Area, Carbon
Tensile Strength, Nickel
Elastic Limit, Mayari
Elastic Limit, Nickel
Tensile Strength, Carbon
Elastic Limit, Carbon
Elongation in 2" Nickel
Elongation in 2" Mayari
Elongation in 2" Carbon
Elongation in 2"
Tensile Strength
Elastic Limit
Reduction of Area
Fig. 7

The percentage of carbon for helical railroad springs is reduced about 10 points from that given above, but the physical results are in practically the same ratio as for leaf springs.

Comparison with Carbon Steel and Nickel Steel

Fig. 7 shows the properties of a 0.40 per cent. carbon Mayari steel compared with a carbon steel and a 3½ per cent. nickel steel, both of 40 per cent. carbon content. The most favorable quenching temperature for each grade of steel was selected and the drawing or tempering temperatures were identical. By a careful study of this chart, it will be seen that the tensile strength and elastic limits of the Mayari steel are from 10,000 to 15,000 lb. per sq. in. higher than those of the nickel steel, except where the drawing temperature approaches the quenching temperature. Here the nickel steel is slightly superior, as in the

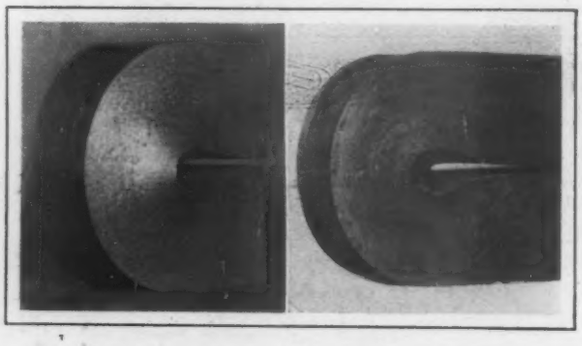


Fig. 8 Fig. 9

Fig. 8—Cold Bending Test. Mayari Steel. Heat Treated. Grade 40-50.

Tensile strength	126,000 lb. per sq. in.
Elastic limit	108,000 lb. per sq. in.
Elongation in 2 in	21.5 per cent.
Reduction of area	62.5 per cent.

Fig. 9—Two-Inch Square Bar of Mayari Steel Bent Cold. Grade 40-50.

Tensile strength	117,000 lb. per sq. in.
Elastic limit	93,000 lb. per sq. in.
Elongation in 2 in	23.0 per cent.
Reduction of area	64.5 per cent.

case of annealed pieces. In the latter condition Mayari steel lies about midway between the carbon steel and the nickel steel. The carbon steel, heat-treated, has about 60 per cent. of the elastic limit and tensile strength of the Mayari steel for the same elongation and reduction of area.

Heat Treatment and Case-Hardening

In heat-treated alloy steels the much superior results obtained are not caused directly by the certain percentage of the various alloying elements, but by the effect of those elements upon the condition of the carbon in the steel. The hardness of a quenched piece and the depth of penetration of the treatment depend upon the rate of change of the carbon from the solid solution form to the combined form; and where this change is sufficiently retarded by alloy additions, higher percentages of this alloy are unnecessary and the benefits obtained do not repay for the cost of this extra amount.

It has been found with Mayari steel, in sections from 1 to 1½ in. thick, that 0.20 to 0.40 per cent. chromium, with the 1.25 per cent. nickel, will develop the maximum properties for that section, and higher percentages of alloying elements do not improve the properties. For larger sections, such as axles, crank shafts and heavy forgings, the chromium should be from 0.40 to 0.70 per cent. to secure the maximum results.

The charts in Figs. 2, 3, 6 and 7 show what results are obtained by treating this steel. These apply to either the higher or lower chromium grades in the smaller sections and to the higher chromium grades only in the larger sections. The quenching temperatures given for these steels are those desired, but 25 deg. Centigrade either way from that given will not materially alter the results obtained.

Case hardening Mayari steel is performed exactly as in the case of carbon steel. The penetration of the carbon, however, is about 25 per cent. deeper for the same time than with the carbon steel. This greater absorption of carbon is due to the chromium content of the steel. The heat treatment for Mayari steel after case hardening should be:

Cool to a black heat from the carbonizing mixture.

Reheat to 810 to 820 deg. Centigrade to refine the core.

Quench in oil or water.

Reheat to 730 to 750 deg. Centigrade, to refine the high carbon case.

Quench in oil or water.

For case hardened parts which are not subject to shock or severe strains Mayari steel of 0.05 to 0.15 per cent. carbon, or grade 10-20 or 10-50 should be used, but if considerable strain and shocks are to be withstood the 20-25 and 20-50 grades should be applied. Those latter grades contain sufficient carbon to be benefited by the subsequent treatment, so that the core, after the above treatment, is exceedingly strong and tough and capable of withstanding severe shocks and stresses.

The lead taken by the automobile industry in using higher grade steels and applying heat treatment has resulted in such wonderful improvements in the quality and life of engine and structural parts, that other industries are beginning to realize the economy of applying the same materials to their uses. Particularly prominent among these are the builders of locomotives and engines, engine forgings, including piston rods, connecting rods, driving, truck and car axles and miscellaneous forgings. Generally these have been made from carbon steels ranging from 0.20 to 0.40 per cent. carbon. Some few builders are using 3½ per cent. nickel steels for rods in the annealed state. Heat treated steels are undoubtedly superior to either the carbon or nickel steels annealed, and aside from the considerably lessened danger of breakage the longer wearing qualities of the properly heat treated steels is sufficient in itself to warrant their employment.

For heat treated axles, piston rods and connecting rods, Mayari steel will give at least 50 per cent. increased properties over carbon steel in the center of the piece.

Explanation of Charts in Figs. 2, 3, 6 and 7

All the pieces for each grade of steel were quenched at the same temperature and then drawn at every 100 deg. Centigrade, beginning at 300 deg. The vertical lines represent this drawing temperature and are marked at the top in Centigrade and Fahrenheit degrees; the horizontal lines represent pounds per square inch and per cent. To the left each line is numbered with the pounds and per cent. The pounds scale applies to tensile strength and elastic limit; the per cent. scale to the elongation and reduction of area. Below the charts are sketches showing the cold bend test for properties directly above; also there is shown below the Shore scleroscope and Brinell hardness numbers for the properties shown on the charts.

The heavy lines are marked "tensile strength," "elastic limit," "elongation in 2 in." and "reduction of area," and the value of each is noted by the scale to the left. Thus for the 0.20 per cent. carbon grade, heated to 860 deg. Centigrade, quenched in water and drawn at 500 deg. Centigrade, the properties obtained as shown on the chart by the intersection of the 500-deg. line with the lines representing the physical properties are:

Tensile strength	142,000 lb. per sq. in.
Elastic limit	122,000 lb per sq. in.
Elongation in 2 in	11.50 per cent.
Reduction of area	47.5 per cent.

The Cascade Tool Company, manufacturer of tools and specialties, Cohoes, N. Y., contemplates building a new shop the coming spring, but most of the equipment needed will be special, now being designed by the company. It is the intention to bring out several new specialties. The company reports its business in most excellent condition, more work being offered than can be handled properly with the present equipment.

The National Conduit & Cable Company, 41 Park Row, New York, has added to its various departments a large brass foundry under special laboratory supervision, for making high-class castings of all descriptions. The high-grade products turned out in the company's other departments should be a guarantee of what to expect from this.

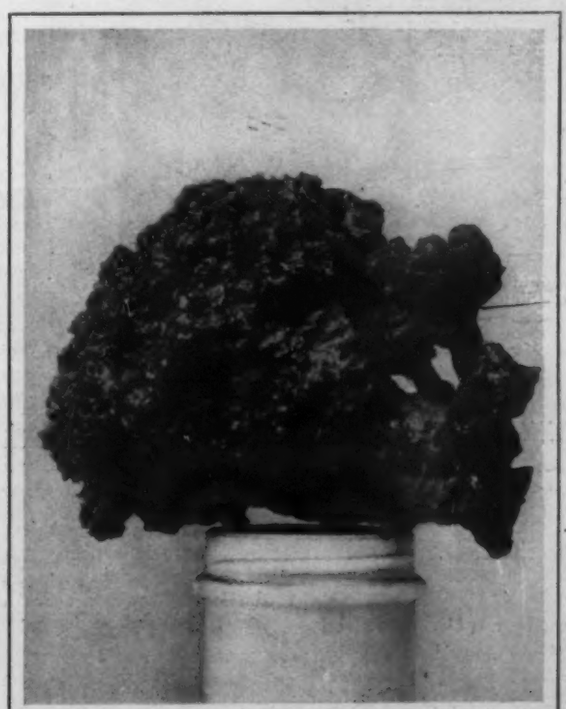
The Sintering of Iron Bearing Materials

Demonstration of the Dwight & Lloyd Process at Birdsboro, Pa., Employing Flue Dust and Fine Ore—Utilization of the Product.

BY JAMES GAYLEY

The Dwight & Lloyd sintering process has been in operation at the works of the E. & G. Brooke Iron Company at Birdsboro, Pa., for several months and has worked with great satisfaction on flue dust and other fine iron bearing materials. The process is not a new one, as some twenty installations are in successful operation sintering lead and copper concentrates. Its use in the iron industry meant no experiment, but was simply the introduction of a well worked out device for a similar purpose in this new field. It is simple and efficient in its operation and produces a product that is ideal for blast furnace use.

The accompanying cuts are from photographs of the Birdsboro plant. The flue dust that has been treated at this plant has varied from 8 to 24 per cent. in carbon; the average being about 18 per cent. carbon. The lower percentage is about right for the perfect working of the process and provides sufficient heat to make a perfect sinter. With the higher per cent. of carbon, the process must be retarded to effect complete combustion. In fact, any excess of carbon above 8 per cent. represents a waste of heat that could be utilized for sintering fine ore. The amount of fine ore that can be added varies according to the quantity necessary to reduce the carbon in the mixture to 8 per cent. The lower the carbon the more compact is the sinter and the product is greater. With flue dust of 8 per cent. carbon the product is 70 tons per day, on the Birdsboro machine. As the carbon increases above 8 per cent. to 18 per cent. the product decreases about 1¼ tons per day for each 1 per cent. increase in carbon. The presence of 25 per cent. carbon is excessive in flue dust, but it shows the great adaptability of the machine to widely varying conditions.



Sample of Sintered Material Showing Cellular Character of Product

The Birdsboro machine is 42 in. wide and treats a layer of flue dust 5 in. deep. The machine can just as readily treat a layer 7 in. deep, which would add 40 per cent. to its capacity, and it can be widened to 60 in., still further increasing its capacity and allowing of a product of 100 tons per day, with carbon considerably above 8 per cent., corresponding to that of the western furnaces using Mesaba ores.

The process is efficient in its operation, and the changes made in its construction will be in the direction of widening the pallet and increasing the depth of material thereon to secure more tonnage. The cost of installing a single unit is about $12,000.

Tests have been made on various kinds of iron bearing material; the results from a few are herewith presented:

Sample Lot of Pyrites Cinder.

	Pyrites Cinder.	Sintered Product.
Iron, per cent	56.28	61.00
Sulphur, per cent	4.41	0.07

Sixty per cent. of the above pyrites cinder was mixed with 40 per cent. of flue dust and no additional fuel added, with the results given in the second table. The sintered product was compact and the rate of production was 75 tons per day.

Mixture of Pyrites Cinder and Flue Dust.

	Pyrites Cinder.	Flue Dust	Average Mixture.	Sintered Product.
Iron, per cent	56.28	33.00	46.97	57.10
Sulphur, per cent	4.41	0.18	2.72	0.12
Carbon, per cent	0.00	24.00	9.60	....

The same pyrites cinder was mixed with an equal weight of magnetic ore concentrates, and 10 per cent. of coal was added. The analyses are shown in a table below. The sulphur in the sinter could have been reduced still lower, as demonstrated by other tests, but unfortunately the supply of this lot of pyrites cinder was exhausted.

The various tests show that pyrites cinder can be mixed with any class of iron bearing material, and produce an excellent sinter.

Two lots of crushed magnetic ore, to which 9 per cent. of coal was added, were sintered with results also shown. The process is not only a sintering one but is also efficient for roasting, and these tests, which were made on small lots of ore, show that a low percentage of sulphur can be reached through a proper study of the treatment necessary for each kind of material.

A sample of spathic ore mixed with 10 per cent. fuel was treated, with the results tabulated. All of the ore before treatment passed through 120 mesh sieve.

In some of the tests mentioned in the foregoing an admixture of 9 per cent. and 10 per cent. of coal is shown, but this should not be considered as the proper amount that would be required in practice; in fact, it would be lower. The purpose of the test was to demonstrate the kind of sinter that could be produced from the material treated and a safe margin of fuel was used.

Mixture of Pyrites Cinder and Magnetic Ore with Coal Added.

	Pyrites Cinder.	Magnetic Ore.	Average Mixture.	Sintered Product
Iron, per cent	56.28	45.61	51.00	56.28
Sulphur, per cent	4.41	2.45	3.43	0.32

Magnetic Ore and Coal Sintered

	Ore.	Sinter.
Iron, per cent	51.10	56.00
Sulphur, per cent	3.50	0.38
Iron, per cent	45.61	52.80
Sulphur, per cent	2.45	0.36

Sintering Spathic Ore with 10 per cent. Fuel.

	Spathic Ore	Sinter.
Iron, per cent	36.96	53.08
Sulphur, per cent	0.82	0.30

A lot of Cuban ore (Mayari) was sintered and showed after sintering a sieve test as follows:

Top View of Sintering Machine Showing Pallets Moving Into Position, Feed Hopper and Bed of Sintered Material Beyond

Sieve Test of Sintered Mayari Ore.

Over 2 in., per cent	45.0
2 to 1 in., per cent	24.0
1 to ¼ in, per cent	18.0
¼ to 1/10 in., per cent	6.0
Through 10 mesh on 20 per cent	5.0
Through 20 mesh on 40 per cent	1.0
Through 40 mesh on 60 per cent	.2
Through 60 mesh on 80 per cent	.6
Through 80 mesh on 100 per cent	.1
Through 100 mesh	.1
	100.0%

In addition is given a sieve test by the Dwight & Lloyd machine of sinter made from flue dust with 18 per cent. carbon:

Sieve Test of Sintered Flue Dust with 18 per cent. Carbon.

Over 2 in., per cent	22.06
2 in. to 1 in., per cent	21.85
1 in. to ¼ in	19.93
¼ in. to ¼ in. (97.9 per cent. over ¼ in.)	34.06
¼ in. to 10 mesh	1.06
10 to 20 mesh	.34
20 to 40 mesh	.33
40 to 60 mesh	.15
60 to 80 mesh	.15
80 to 100 mesh	.05
100 to 120 mesh	.02
120 to 150 mesh	.00

The last table covers a comparative sieve test of the Dwight & Lloyd product with the average product of the revolving kiln made at the sintering plant.

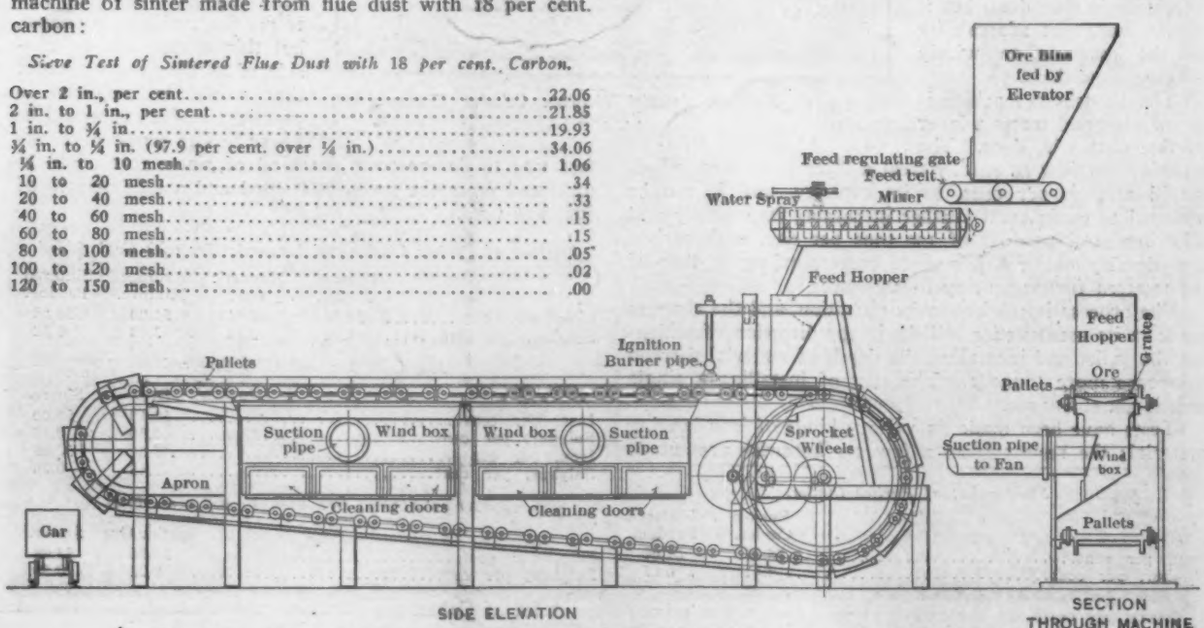
A large number of tests have been made on various kinds of iron bearing material with satisfactory results in each case, but those given above are deemed sufficient to demonstrate the wide range of materials that can be treated.

The Dwight & Lloyd product from flue dust is not suited to the open hearth furnace, as it is too cellular, but this structure makes it ideal for the blast furnace. To produce open hearth material from flue dust it must be briquetted, and in order to briquette it properly the carbon must be removed; and since it must be briquetted for open-hearth use, would it not be simpler to go a step further, by screening out and briquetting the fine Mesaba ores which produce flue dust, make a better briquette, and convert the flue dust cheaply into good furnace stock? Concentration not only entails considerable expense but also results in a loss in iron. Moreover, the open hearth requires the peroxide of iron. The fuel that has been wasted through the top of the furnace becomes of no value in the briquetting process, nor is it of any noticeable value in the revolving kiln for sintering; while in the Dwight & Lloyd process the sintering is effected by the fuel contained in the flue dust, and usually there is a surplus of fuel, which can be used to sinter a considerable quantity of fine ore.

Comparison of Products of Sintering and Revolving Kiln Processes.

	Dwight & Lloyd	Revolving Kiln.
On ¼ in. mesh, per cent	63.84	26.8
On 10 mesh, per cent	35.12	54.0
On 60 mesh, per cent	0.82	18.2
Below 60 mesh, per cent	0.22	1.0
	100.00	100.0

It has been claimed that briquettes which show porosity, through their capacity to absorb water, is an indication of their reducibility, and that they are of equal value in the furnace with a sinter that is cellular in structure; but this is not in accordance with the facts. Reduction is



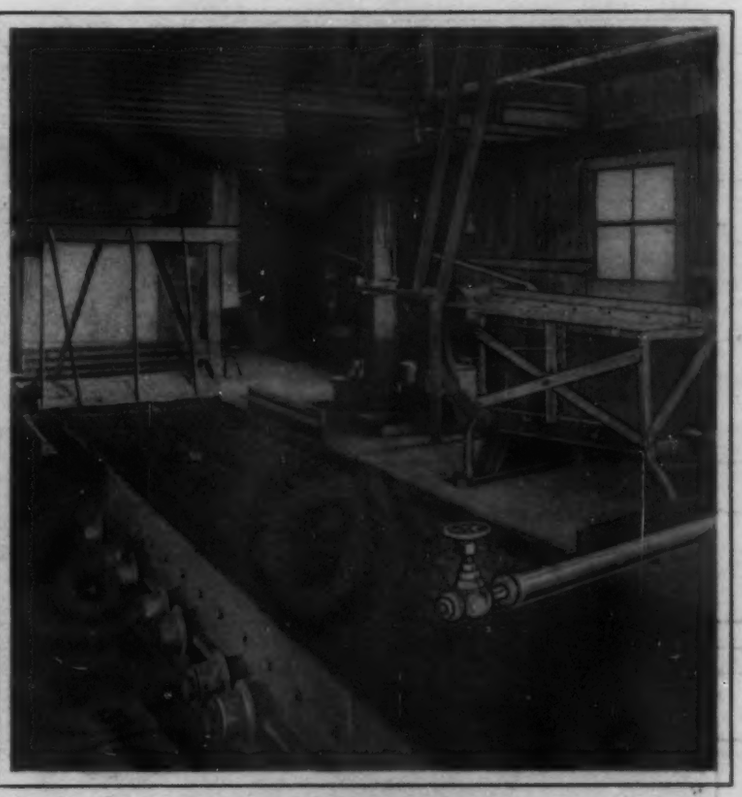
Elevation and Section of Flue Dust Sintering Machine, E. & G. Brooke Iron Company, Birdsboro, Pa.

more readily effected when the ore mass is heated throughout. The briquette has its pores filled with air, which must be driven out by the furnace gas; the air absorbs heat in expansion, and besides it is a poor conductor of heat. The Dwight & Lloyd cellular sinter has solid but thin walls, and the heat is readily conducted through the walls. This also holds true in the burning of lime, for a porous stone is not so readily calcined as a more compact one, when crushed to the same size. The cellular structure provides more area of contact. To quote Schinzlaw (in his "Action of the Blast Furnace): "A chemical action can only take place between two bodies, however great their affinity, if they are in intimate contact with each other; and the rapidity of this action will be so much greater, the more numerous the points of contact are." The material which provides the greatest area of contact is more readily and economically reduced in the furnace.

The down draft employed in the Dwight & Lloyd process creates channels or avenues through which the ascending gases of the furnaces pass and readily effect the reduction of the material. Another advantage of the Dwight & Lloyd process in addition to desulphurizing and producing a cellular product is in its effecting a partial reduction of the ore and thus relieving the furnace of a definite amount of work.

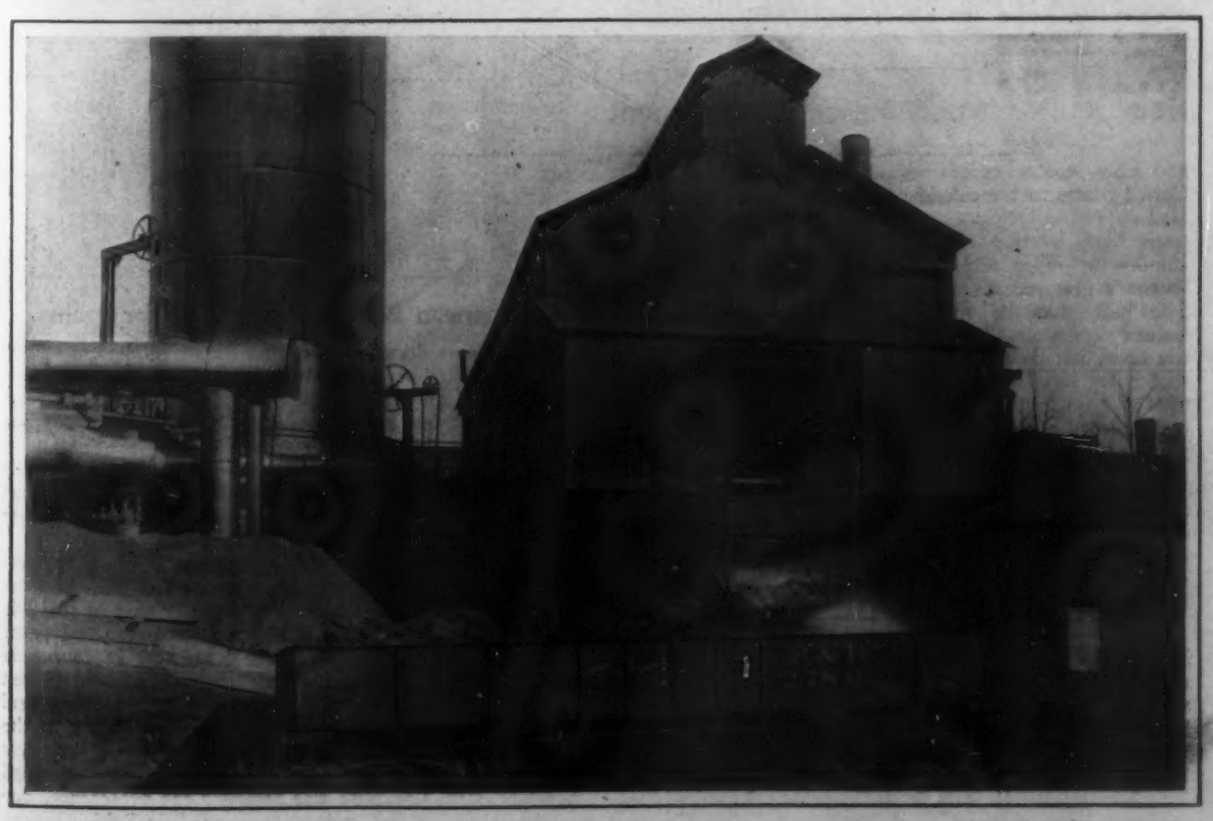
The presence of the magnetic and the lower oxides in sinter has been objected to by some, and in support of their position, the more difficult reducibility of magnetic ore and puddle cinder as compared with the hematites is cited. The first whiff of gas in the top of the furnace speedily reduces the ore to the magnetic oxide, and this oxide is quickly lowered.

The difficulty with magnetites and puddle cinder is due to their compact structure. The reducing gases are unable to penetrate the mass, and reduction is effected superficially, just as anthracite coal burns; the mass may be glowing on the surface, but at a short distance in it is black. If these materials were given a cellular structure they would be readily reduced. This is a fact well known to furnacemen of the days of the puddle furnace, when the bosh cinder was preferred to the tap cinder.



Pallets Containing Sintered Material

With the iron industry at Pittsburgh and the West depending principally on Mesaba ore for its supply and the consequent production of flue dust, the proper agglomeration of this waste material becomes a matter of very great importance. Hitherto it has been attempted in as crude a way as that of blast furnace practice fifty years ago, when ores of great variety were charged into the furnace, expecting it to "do the rest." The prevailing opinion was



View of Discharge End of Conveyor of Flue Dust and Fine Ore Sintering Machine at Birdsboro, Pa.

well expressed by an old Cornish miner in Eastern Pennsylvania, who told the writer many years ago that "a ton of ore is a ton of ore all the world over." Flue dust has been treated much in the same way. Material varying widely in carbon is charged successively into the kiln, and it is expected to produce a satisfactory product. A systematic analyzing of the dust, combined with a proper grading and mixing, will greatly improve the sintered material for blast furnace use.

Underside View of Sintering Conveyor, Showing the Exhaust Gas Boxes

New Railroad Building and Equipment

The annual statistics of the Railway Age Gazette show that only 3066 miles of new main line was built in the United States in the calendar year 1911, as compared with 4122 miles the previous year. This is the smallest figure since 1897, when 2109 miles was added. The average number of miles added each year is 3885, since that journal's first records of 1893. The 1910 record was 374 miles more than the preceding year. These figures do not include new second, third or fourth track, sidings or electric lines, nor do they include relocated lines. In Canada 1898 miles was built, against 1844 in 1910. In Mexico the total was 351 miles in 1910 and 138 in 1909. The following is the record of new main line in the United States for the past 19 years:

	Miles		Miles		Miles
1893	3024	1900	4894	1906	5623
1894	1760	1901	5368	1907	5212
1895	1428	1902	6026	1908	3214
1896	1692	1903	5652	1909	3748
1897	2109	1904	3832	1910	4122
1898	3265	1905	4388	1911	3066
1899	4569				

Cars and Locomotives Built and Ordered

The same journal gives the statistics of cars and locomotives built and ordered in 1911 in the United States and Canada. The number of cars and locomotives actually built in the year is smaller than the average for the past 10 or 12 years, and in the case of freight cars is actually less than for any year during which these compilations have been made. Reports from the principal car and locomotive builders in the United States and Canada indicate that the total number of freight cars built in 1911 was 72,161; passenger cars, 4246, and locomotives, 3530. The figures for 1910 were: Freight cars, 180,945; passenger cars, 4412, and locomotives, 4755.

Of the freight cars built in the past year 68,961 were for domestic service and 3200 for export. Of the freight cars 52,592, or approximately two-thirds, were of all-steel construction or had steel underframes, and of the passenger cars 2930, a slightly higher proportion, were of all-steel construction or had steel underframes. The following table shows the cars built in the past 13 years.

Year	Freight	Passenger	Total
1899	119,886	1305	121,191
1900	115,631	1636	117,267
1901	136,950	2055	139,005
1902	162,599	1948	164,547
1903	153,195	2007	155,202
1904	60,806	2144	62,950
1905*	165,155	2551	168,006
1906*	240,503	3167	243,670
1907*	284,188	5457	289,645
1908*	76,555	1716	78,271
1909*	93,570	2849	96,419
1910*	180,945	4412	185,357
1911*	55,931	3566	59,507

*Includes Canadian output.

Returns from locomotive builders show that 3530 were built in the year, of which 3143 were for domestic service and 387 for export. The record for 19 years is as follows:

Year	No. Built	Year	No. Built	Year	No. Built
1893	2011	1900	3153	1906*	6952
1894	695	1901	3384	1907*	7362
1895	1101	1902	4070	1908*	2342
1896	1175	1903	5152	1909*	2887
1897	1251	1904	3441	1910*	4755
1898	1875	1905*	5491	1911*	3530
1899	2475				

*Includes Canadian output.

The number of cars and locomotives ordered last year is more favorable than the number built, which is the reverse of the statistics for 1910. The number of locomotives ordered was 2850. The number of passenger cars ordered was 2623. The number of freight cars ordered in 1911 was 133,117, which is the smallest number ordered in any year since 1901, except 1903 and 1908. The record for 11 years is as follows:

CARS AND LOCOMOTIVES ORDERED

Year	Locomotives.	Cars. Passenger.	Freight.
1901	4340	2879	193,439
1902	4665	3459	195,248
1903	3283	2310	108,936
1904	2538	2213	136,561
1905	6265	3289	341,315
1906	5642	3402	310,315
1907	3482	1791	151,711
1908	1182	1319	62,669
1909	3350	4514	189,360
1910	3787	3881	141,204
1911	2850	2623	133,117

American Bath Room Fittings for Spain

The export department of the Standard Sanitary Mfg. Company, Pittsburgh, of which F. R. Johnson is manager, has received an order from Spain, calling for bath tubs, lavatories, closets and accessories for 18 bath rooms for the new La Magdalena summer palace at Santander, Spain. These are for rooms to be used by the royal children, palace officials and visitors. Bath room furnishings for use by the King and Queen, to be much more elaborate and complete, will be ordered later.

Hitherto, San Sebastian has been the fashionable summer resort for Spanish royalty, high officials and the aristocracy, but now it is intended to transfer part of this life to Santander, also on the north coast and on the Bay of Biscay. The palace of La Magdalena, now in course of construction, is being presented to the King and Queen by the Spanish nation. The Queen, who was born and educated in England, has insisted upon everything in the palace being modern, and particular attention has thus been given to the sanitary equipment. The Standard Sanitary Mfg. Company was awarded the preference, due to the merits of its products, over leading British manufacturers.

Making Mileage Recording Instruments

Shop Methods, Wage Payments and Manufacturing Processes in Producing Small Duplicate Parts at Works of Warner Instrument Company, Beloit, Wis.

The manufacture of speed and mileage recording instruments, involving the making of many small duplicate parts in quantity, has presented an opportunity for the development of interesting shop methods. Where the instrument is of the quality made by the Warner Instrument Company, Beloit, Wis., the machining is required to be precise. In conjunction with this requisite an economical and expeditious handling and accounting of the material is essential.

The complete manufacture, assembly and test of these instruments comprises between 200 and 300 distinct operations. A part of these operations are punch press work, such as the blanking and forming of the links for a flexible shaft; the cutting out from sheet brass of the odometer side plates, and the drawing of the brass cup in which the instruments are encased. Other parts are worked up on automatic machines—small screws, link pins, small bevel gear blanks, and, of unusual character, like small worm drive spiral gears. The bezels for the instruments with glass dials are a part of the work machined on a group of turret lathes. The small brass bracket castings, slotted pins and burrs are turned out on a group of small millers. In addition to the machine work a large proportion of the operations, such as fitting, polishing and testing, can be done only by hand. In whichever of these or other departments a piece is handled each part is listed and known by a symbol and each successive operation in the finishing of that part is numbered.

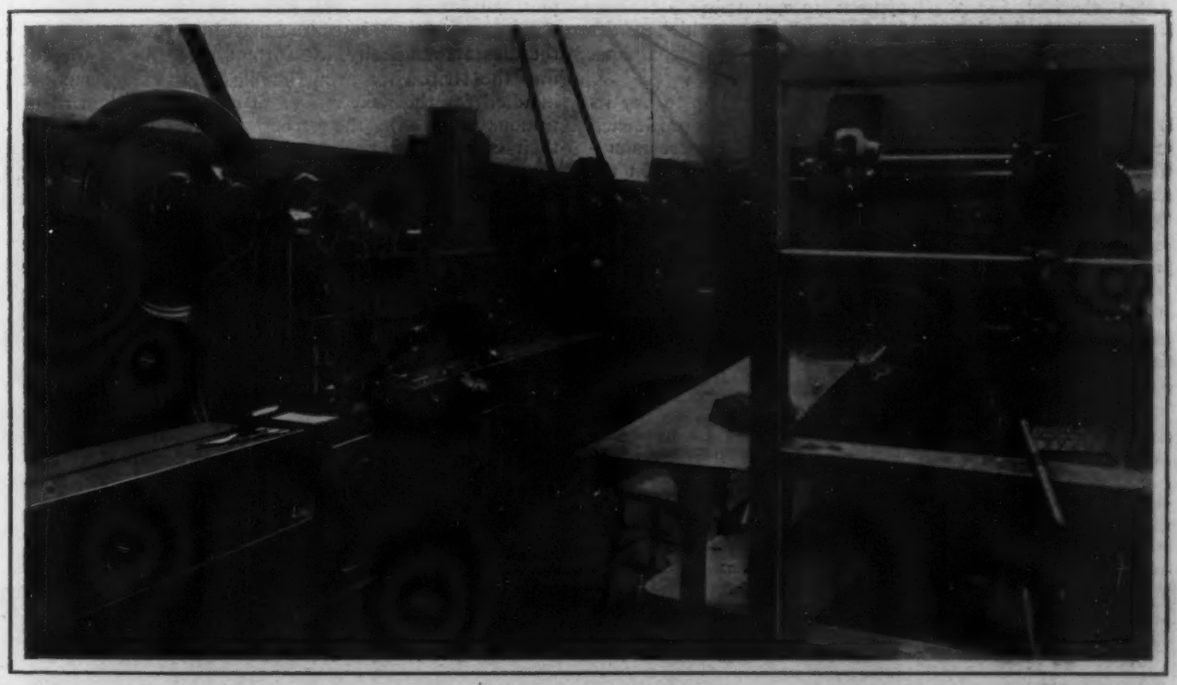


Fig. 1—Group of Presses for Blanking Out Flexible Shaft Links and Sheet Brass Parts

Uniformity of the product admits of putting all work through the shop on stock orders and of making all shipments from stock. To insure against the complete depletion of any part or instrument in stock, the continuous stock inventory record provides for the requisitioning of an additional supply as soon as the pre-established minimum balance is reached. This requisition is sent to the cost department by the stock clerk and is issued in addition to a report of the stock made at regular intervals to the shop superintendent. On this requisition the cost department issues a general shop order for a specified number of the complete items required. This order goes to a distributing clerk who issues individual instructions under the general order, covering each operation involved and stating the number of pieces upon which each operation is to be performed. Through the foreman of each department, the workman then receives instructions accordingly. While it is sometimes necessary to shift men from one operation to another, ordinarily an employe works continuously at the same machine and tasks.

For each of the above operations, depending upon its character, a fixed time or straight piece rate is established. The operator makes out his daily time card accordingly on the basis of hours or number of pieces, applying it against the stock order number. In many instances both time and piece work may appear on the card, which is arranged in simple form to provide for this contingency. In the case of piece work, trays are provided for receiving the parts as they are finished. In each tray the workman places a ticket on which is his number, the order number and the number of pieces, according to his count. From the workmen these trays pass directly to a stock checker. No third person is permitted to touch the finished work and any difference in count is thus directly between the workman and checker.

The repetition of familiar work and rates of payment therefor make it easy for the workmen to keep an accurate record and few discrepancies occur. On a given order any number of pieces may be taken from the machine if necessary at any time as the pieces in each tray are fully accounted for independently of the balance of the order by the ticket which accompanies each tray. Each night every finished part in the shop is required to be delivered to the stock checker. At an early hour the next morning the cost department has the checker's record of the number of pieces manufactured up to the previous night, together with the time charged against them. The status of the work in the shop is thus available daily almost up to the hour.

The finished material slips made out by the workmen and sent to the stock checker with the work are delivered in turn by him to the cost department. Here they are

Fig. 2—Acme Automatic Machine on Which Small Worm Spiral Gears Are Made at the Rate of One a Minute

again checked for the payment rate, number or time, against the daily time card of the workman which comes through the department foreman and for total time, against the workman's clock card.

The company's cost system requires the shop to pay its own way and as a result the shop seeks to make a profit each month on the work delivered to stock. Each piece manufactured is credited at an established shop price. On the basis of these prices and the amount of work turned out by the shop the value in dollars and cents is figured monthly. Against this credit the shop is charged with all material, labor and fixed plant expense, and in addition bears other specific charges which have been apportioned as a part of the shop's burden. The profit which the shop can show from month to month is in a general way a measure of additional manufacturing economies effected, as compared with previous actual costs.

The operations performed on the group of punch presses shown in Fig. 1 are arranged to take advantage of sub-press work. On the machine at the left links are blanked out from 7/8 in. strip steel for the flexible shaft which drives the instrument from the main gear on the wheel of the vehicle at the same time the holes are also punched for rivets. The strips are laid out on the tables shown on either side of the machine and are fed through the dies automatically, the formed pieces being forced back into the strip after being blanked out. They can thus be handled for the next operation still in the form of a continuous strip. On the second punch the links are given their concave form. The flexible shaft consists of two of these links alternating with a flat link, all being riveted together with small pins which are turned out on an automatic machine at the rate of 20 a minute. Such parts as these when delivered to the checker at night are placed in what is known as the assembly room stock. The assembly room then obtains them out of this stock as required. The assembling of the flexible shaft is done by boys and girls working at benches. One operator has a form over which the concave link fits and into which the two rivets may be inserted. The two pins are then riveted by hand into the first link. Another girl strings alternately on a wire the other curved link and the flat link for completing the unit. A third operator receives the work from the first two and assembles the three pieces and builds up the shaft, riveting the other ends of the pins.

In Fig. 2 is illustrated one of the most interesting ma-

Fig. 3—Small Lathe With a Cam Actuated Movable Tool Holder for Machining an Elliptical Concave Flange

Fig. 4—Turret Lathe on Which the Brass Bezels Are Cut from Brass Tubing

chines in the plant and a tool which was developed to its present rate of production only after much experimenting. It is a combination Acme four-spindle automatic machine with hobbing attachment. At the rate of one a minute this tool finishes complete from plain round bar stock, a worm spiral about 9/16 in. diameter with 5/16 in. bore ⅝ in. long. Formerly these spirals were cut off and bored on a turret lathe from bar stock previously cut for the helical thread. Those with a left-hand thread are still made in this manner. The machine illustrated successively gauges the stock, centers it, drills the bore and with the vertical hobbing attachment shown simultaneously cuts the spiral, then reams the bore and cuts off the piece with the required turning up of the end.

The flexible driving shaft enters the brass cup of the instrument at an angle and is supported by a flange boss brazed to the cup. In order to face such a surface as this flange presents on the lathe a special rigging has been devised. The small lathe used for this work is shown in Fig. 3 and on the bed of the lathe is one of the flanged bosses to be finished, from which the contour of the flange is apparent. The cutting tool is mounted in guides and is arranged to reciprocate in a direction parallel to the spindle. Through an index rod held against the face of a cam mounted on the spindle of the lathe, motion is communicated to the cutting tool. The face of this cam is a reproduction of that required for the finished flange. As the cam rotates and the index is fed across its face, the cutting tool moving across the face of the flange duplicates the contour of the cam thereon. Machining in this manner produces a fit which the inspection requires to be exact without any hand work.

The bezels for holding the glass front for the larger instruments, instead of being stampings, are turned from solid brass tubing. This tubing, previously cut in short lengths, is turned off into rings of the desired width on a turret lathe as illustrated in Fig. 4, the piece being chucked on a face plate with one end free. On a second lathe one side of these rings is counterbored and turned to a thin edge for the insertion of the glass plate, the thin edge being subsequently clinched over the glass. At the same time the exterior of the ring is turned up to an ornamental finish. The final operation consists of cutting a thread on the opposite side of the ring for screwing the bezel on the brass cup.

In the mounting of the instrument a number of small brass castings are required as brackets and fixtures. In most instances these are required to fit irregular surfaces

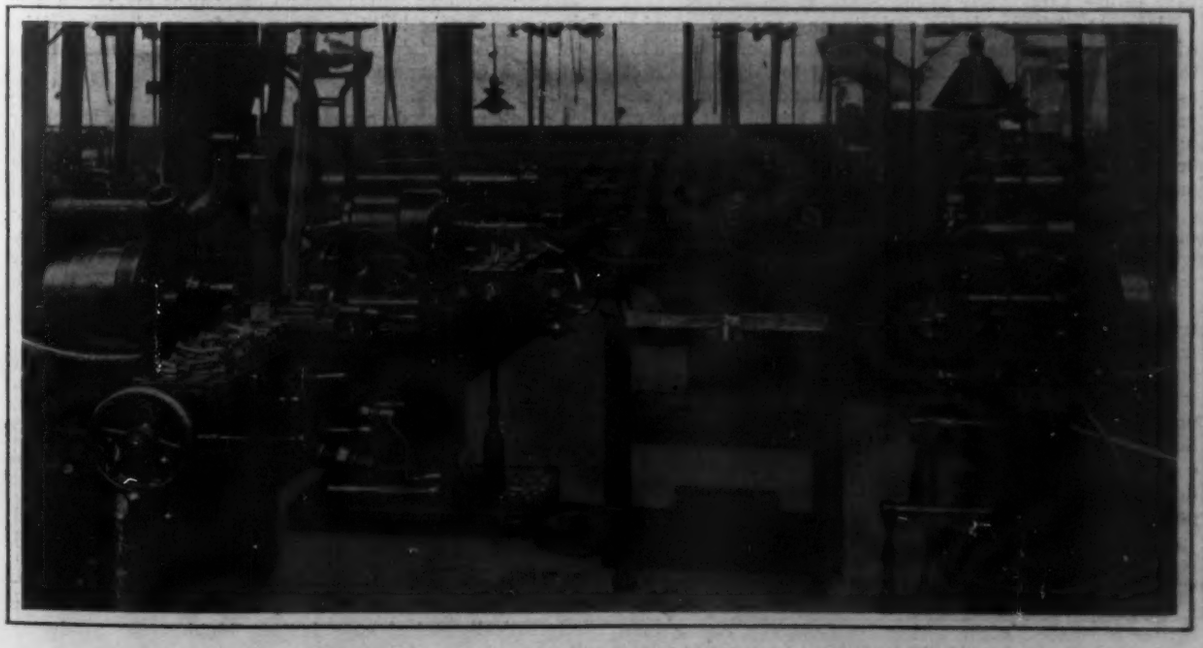


Fig. 5—Milling Machine Group for Finishing up Brass Bracket Castings and Slotting Burrs

Fig. 6—Double Horizontal Miller for Cutting Small Bevel Gears

and in Fig. 5 some of the milling machines are shown on which this work is done. Specially shaped cutters are used, some of which complete the surface in one operation, while in other instances more than one cutter is necessary. The castings are set in jigs and it is not ordinarily necessary to clamp them in place.

An interesting method of cutting very small bevel gears is illustrated in Fig 6. The nature of the operation and the arrangement of the machine are fairly clear in the view presented. The blanks for the gears are finished on an automatic machine. The blank is mounted on a finger and held in place by a short screw. The finger rotates the blank as the teeth are cut. The cutter finishes one side of each tooth in one complete rotation of the blank and by shifting the lever the other side of the teeth are finished during the second rotation. The operator runs the two sides of the milling machine alternately and two gears can be finished complete, including the time of mounting the blanks and the time of removing the finished gear, in three minutes.

Baltimore Business Notes

Dietrich Brothers have recently taken a number of contracts for small and moderate-sized steel buildings, including an addition to the plant of the Continental Brewing Company, for which J. Henry Miller, Inc., has the general contract. The Maryland Casualty Tower Building, for which this firm has the contract for the structural work, is now 90 per cent. erected. While there is little new structural business of importance under negotiation at present, the outlook for more active conditions in the near future, particularly in the South, is encouraging.

John D. Adt continues actively engaged. A number of orders are in hand for special machinery, including tobacco working equipment for export to Algeria as well as for domestic customers. The demand for power elevators has been less active. A large amount of general machine work is under way. While the past year has been the most active in the history of the business, the outlook for a larger volume in 1912 is considered favorable.

The Thomas C. Bashor Company took a large amount of new business in December. Boiler and tank work, which was light during the fall months, increased materially and this department of the company's plant is now fully engaged. Among recent orders were three boilers, two 14 ft. and one 16 ft. long, and each 72 in. in diameter, for the Wiesner Brewing Company, and a 72-in. x 18-ft. boiler for the Davidson Chemical Company. Special work taken includes tanks, dryers and cookers for fish factory use. One order calls for a complete equipment for a new fish factory in New Jersey. The year's business with this company has been above the average, even though several dull months were experienced. Considerable inquiry for power equipment and special equipment is in hand.

The Aumen Machinery & Supply Company notes a seasonable business, with a greater volume moving in special lines. A better inquiry for pumps and accessories is enjoyed. A 14 x 24 x 24-in. condenser and pump has been sold to the Knickerbocker Ice Company, and a number of orders for smaller pumps have been taken. The general inquiry for tools and equipment is better, and the prospect for more active conditions this year is most promising.

The Monarch Engineering & Mfg. Company has recently taken some very good orders for its line of Steele-Harvey crucible metal melting and refining furnaces. D. R. Steele, formerly the senior partner, has retired and H. D. Harvey has assumed ownership of the company. James J. Allen is general manager. The capacity of the plant is to be largely increased, but details are not yet announced.

The Spedding Shipbuilding Company is erecting a new three-story office building, 25 x 75 ft., on the site of its old office on Boston street. The second floor will be fitted up for a drafting room.

Important bridge work is being considered by city officials. Plans include a concrete general traffic bridge over Stony Run, to be used jointly by the city and the United Railways Company, for which tentative plans are being made by J. W. Shirley, chief engineer of the topographical survey. This bridge will probably cost upward of $1,000,000. Another bridge, over Spring Gardens at Light street, has been recommended by the Harbor Board. Concrete construction is also being considered for this bridge, which would cost upward of $600,000.

Attorney C. H. Huston has been appointed temporary receiver of the National Rolling Mills Company, Mansfield, Ohio, as a result of involuntary bankruptcy proceeding brought in the Federal Court. It is stated that the indebtedness of the company will not exceed $41,000 and it is believed that full settlement will be made with the creditors.

The Youngstown Sheet & Tube Company, Youngstown, Ohio, has placed a contract with the Wellman-Seaver-Morgan Company, Cleveland, Ohio, for 18 10-ft. latest design automatically poked cone bottom Hughes gas producers for its new open-hearth plant now under erection.

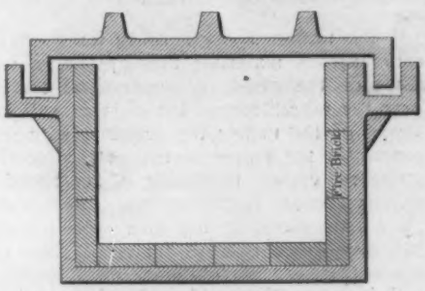
The Carbonizing of Steel by the Use of Gases

Alloying Metals That Retard or Further the Penetration of Carbon — Some Modern Commercial Revivals of an Old Process

BY E. F. LAKE

How long the carbonizing process has been used in the manufacture of steel products is questionable. Cementation may indeed have been the first method employed for making steel. Historical records would indicate that iron or steel was made more than 5000 years ago by a process whereby the ore was reduced to a product similar to the wrought iron of the present day. Then our ancient steel makers heated this in closed furnaces with charcoal and thus caused it to absorb the necessary amount of carbon to convert it into steel.

While the science of quantitative chemistry is but little more than a century old and hence the earliest steel makers did not fully understand the affinity between the different elements and the great attraction that iron and carbon have for each other, the most natural thing for them to do was to use wood for fuel when heating this iron for the purpose of working it into the desired shapes. That this wood would become charcoal; that the charcoal, when burnt in the presence of air, would give off large quantities of carbon-dioxide, and that this gas would penetrate the iron and carbonize it were only natural chemical



Cast Iron Box for Carbonizing Steel

changes that took place, even though not understood. After the usefulness of iron had been established, the natural evolution of its manufacture carried it along these lines.

Early Methods and Later Modifications

History has well established the fact that for at least 1000 years bars of steel were heated in close contact with charcoal or other materials, and carbon added to the metal in that manner. It often took from 10 to 12 days to get the carbon to penetrate more than a thin layer that formed the outer skin of the piece. Muffle furnaces were later brought into use, and these much shortened the time in which the carbon would penetrate to a certain depth and also increased the depth of penetration. The main principles of the process, however, are the same now as they were centuries ago.

While armor plate and many other products are manufactured by the carbonizing process, a great majority of the steel products now have the carbon raised or lowered to the proper percentage while they are in the molten state. At present, therefore, the carbonizing process is only used for specific kinds of work. It is the only method by which a single piece of steel can be given an extremely hard outer surface, with its accompanying brittleness, and still have a soft, tough center or core, so that it will bend and not easily break. Thus the carbonizing process is used for manufacturing a large variety of steel parts for numerous machines, instruments, etc., and its use is on the increase.

Several different methods are used for introducing the carbon into the steel, and others may be devised in the future. The Harveyizing process, that is especially applicable to armor plate, places a layer of charcoal between two plates and then heats them in a pit furnace to a temperature that will cause the steel to absorb carbon from the charcoal. The weight of the upper plate keeps the charcoal in close contact with the surfaces of both plates and facilitates the soaking in of the carbon. This method is only suitable for large work, and the depth of penetration is very unequal over the entire plate surfaces. The Krupp process for armor plate uses a gaseous hydrocarbon to replace the bed of charcoal. Electricity has also been used to heat the plates after placing carbonizing materials in contact with them.

Methods for Small Pieces

Practically only two methods are used for carbonizing small pieces. The older method consists of packing the work in some carbonaceous material, within an iron box, and sealing the cover with fire clay or other refractory material so the air will not get in or the carbon escape. This is then placed in an oven and held at a carbonizing temperature for a time sufficiently long to allow the carbon to penetrate to the required depth. An iron box that is often used for this purpose is shown in the accompanying illustration. The other method consists of placing the pieces to be carbonized in a retort and then filling this with a carbonaceous gas while the work is held at a carbonizing temperature.

All of these methods are but variations or slight improvements of the process used by ancient steel makers, when they dug a hole or pit in the hillside, heated the metal in the presence of charcoal and thus caused it to absorb carbon. The Harvey process improved on this by digging its pit in the floor of the steel mill and making the charcoal before it was placed between the armor plates. The Krupp process varied this by making a carbonaceous gas from the solid materials and injecting this into the pit in place of the charcoal. The gas method used for small pieces improved the Krupp process by using a muffle furnace instead of a pit in the floor.

The vast improvements that have been made in machinery, together with the advance in chemistry and in the methods of producing all useful articles, have made this latter method of carbonizing with gas a distinct process by itself. It has only been perfected and given a commercial application in the past five years, and thus should be considered as a new process. Since its advent much experimentation has been conducted with different kinds of gases and these compared with the solid carbonaceous materials and methods of carbonizing with them.

Effectiveness of Gas Carbonizing

These investigations have all proved that carbonizing with gas in a muffle furnace is far superior to any method or process that uses solid substances. The carbon penetrates the metal in much quicker time than when solid materials are used; it can be made to penetrate to a greater depth; the percentage of carbon in the muffle can be maintained at an established point, owing to the fact that fresh gas is continually flowing in, while the used gas is escaping, whereas, when the work is packed in sealed boxes, no carbon can be added to that which is first placed there; uniform results can be obtained with different lots, owing to the ease with which gas is controlled, and a uniform depth of penetration and percentage of carbon will be obtained over all the exposed surfaces of the pieces, and in all the pieces in the retort or muffle. Aside from this, the labor of packing the work in iron boxes and then sealing on the cover is entirely dispensed with.

The Gases Used

The carbonaceous gases that have been experimented with for carbonizing are carbon monoxide, carbon dioxide, illuminating gas, methane, ethylene and gases made from liquids like petroleum, naphtha and gasoline. Below is

given a list of these gases, with the percentage of the carbon and the depth of penetration.

Kind of gas.	Time in hours.	Depth of case in inches.	Carbon content, per cent.
Illuminating	4	None	None
Illuminating and ammonia	4	0.008	0.78
Illuminating and ammonia	8	0.012	1.14
Carbon monoxide	0	0.016	1.36
Carbon monoxide and ammonia	4	0.016	1.45
Acetylene	4	No demarkation	0.41
Acetylene and ammonia	4	0.012	0.98
Methane	4	No demarkation	0.26
Methane and ammonia	4	No demarkation	0.32
Naphtha and ammonia	4	0.014	1.02

The science of chemistry has made such a great advance in the past century that we now have quite an extensive knowledge of the materials that will cause carbon to penetrate a solid body of iron or steel from the outside or that may be used to add carbon to the molten metal. Nearly every carbonaceous material has been investigated and the amount of carbon that each will cause the different iron products to absorb has been recorded. The speed and depth of penetration have also been investigated. In thus adding it, the carbon enters into solid solution with the iron. Many of the other elements that are used in the manufacture of the ordinary or alloyed steels either retard or aid the penetration of carbon.

Effect of Alloying Metals on Carbonizing

Manganese has a tendency to make the carbonized surface brittle when it has been hardened and thus render it liable to chip off, peel and break, with slight shocks. The manganese in carbonizing steel is usually kept below 0.20 per cent. and seldom exceeds 0.50 per cent. Manganese, however, aids in the penetration of the carbon, and for that reason should be kept as high as possible.

Nickel usually has a tendency to obviate the brittleness that is produced in steel by carbonizing and also makes it more homogeneous. When a 2 per cent. nickel steel is properly heat-treated and carbonized the tensile strength can be made to nearly double that of ordinary carbonized steels. Nickel, however, retards the penetration of carbon; thus it will take considerably longer to carbonize nickel steels to a required depth than those that do not contain nickel. Some very recent experiments on steels containing from 2 to 30 per cent. of nickel showed that when using pure ethylene and carbon monoxide, the maximum carbon content in the zone of cementation diminishes as the percentage of nickel increases and becomes very marked when there is more than 5 per cent. of nickel. Variations in the percentage of carbon in the different layers were also much less than in carbon steel.

Silicon when added to steel will raise the tensile strength about 80 lb. for each additional 0.01 per cent. until a silicon content of 4 per cent. has been reached, and will lower the elongation and reduction of area. Thus, while silicon is desirable for its strengthening properties, it retards the penetration of carbon to a greater extent than any other element. When steel contains 4 per cent. of silicon it is almost impossible to make carbon enter it. With 1 per cent. of silicon the speed of penetration is only about one-half that of a normal steel. Thus the silicon has to be kept low in steels that are to be carbonized.

Chromium increases the rate of penetration more than any other element except manganese. It also greatly refines the grain and prevents the development of the crystalline structure in steels that are being heat-treated, and tends to produce a mineral hardness. Thus greater strength and wearing qualities can be obtained with chromium steel than with any of the others and the carbon will penetrate it more freely and evenly while being carbonized. When the chromium is too high, however, the steel cannot be cut with any machine tools, and hence parts that are to be machined must be kept low in chromium. The percentage of carbon in the zone of cementation is also greater in chromium steels than in ordinary carbon steel.

Tungsten and molybdenum are about equal with chromium in regard to increasing the rate of penetration, but these elements are only used in high-speed tool steels, and carbonizing has been resorted to in only a very limited way for cutting tools. Many kinds of such tools could doubtless be well made by the carbonizing process, but each time they were ground would reduce the percentage of carbon in the cutting edge and this would soon reach a point that would make it impossible to harden the tools sufficiently to cut other metals.

Vanadium, titanium, aluminum and like purifying elements produce high dynamic qualities and give to the core of carbonized steels a high resistance to shocks. This is due to the fact that they have an affinity for oxygen, hydrogen, nitrogen and like gases, and remove these from the metal. In the small percentages in which they are used for scavenging they neither retard nor promote the penetration of carbon when carbonizing steel.

The following table shows the influence of different elements on the speed of penetration of the carbon when carbonizing a steel whose other elements were uniform, *i. e.*, the carbon, phosphorus, sulphur, etc., were in the same percentage throughout all of these tests:

Per cent.	Element in alloy.	Penetration of carbon per hour in inches.
0.5	Manganese	0.043
1.0	Manganese	0.047
2.0	Nickel	0.028
5.0	Nickel	0.020
0.5	Silicon	0.024
1.0	Silicon	0.020
2.0	Silicon	0.016
4.0	Silicon	0.000
1.0	Chromium	0.039
2.00	Chromium	0.043
0.5	Tungsten	0.035
1.0	Tungsten	0.036
2.0	Tungsten	0.047
1.0	Molybdenum	0.036
2.0	Molybdenum	0.043

Carbon Monoxide Gives Best Results

It is of the utmost importance to know the analysis of the carbonaceous materials that are to be used, and the influence on the speed of penetration; the depth of penetration; the percentage of carbon that will be in the various layers of the metal; the evenness with which the carbon penetrates the entire surface, etc. From all that can be gathered, carbon monoxide is far ahead of any of the solid materials in the specific direct carburizing effect it has upon steel. It has also proved itself to be better than any other gaseous material. The depth of carbonization that can be obtained in a given time is greater with it than with anything else that has been tried. Moreover, the percentage of carbon and the depth of penetration can be controlled at will by the use of this gas in its pure state or in combination with other elements. This is something that is very difficult to do with any of the other carbonizing materials, and especially with the solids.

Cautions to Be Observed

In using carbon monoxide, however, one should know its chemical composition, as well as other conditions under which it is used, before trusting it too far. Pure carbon monoxide would without question be the best carburizing material if it were not for two conditions: The first is that it causes the carbon to penetrate the steel so rapidly that it leaves a distinct division between the core and the carburized zone. When the carbonized piece is hardened, therefore, the carburized outer shell has a decided tendency to crack and peel off. The second is that pure carbon monoxide increases the tendency toward oxidation, and steel parts often show a decided scale on their surface.

Such conditions can be overcome or regulated by mixing with the carbon monoxide small quantities of hydro-carbons of known composition, or solid carbon in a properly divided state. These might be injected during all or only a portion of the carbonizing time. A combination of the solid and gaseous processes has been made, therefore, in one style of furnace. This is done by sending a current of carbon dioxide through a cylinder that is filled with wood charcoal and in which the work is packed. Thus, when the work is at the carbonizing temperature, a mixture of carbon dioxide and carbon monoxide is rapidly formed and there is no possible excess of carbon monoxide. While the gas entering the apparatus is dry carbon dioxide, that which issues therefrom is almost pure carbon monoxide; it contains less than 3 per cent. of carbon dioxide, while its volume is about double that of the gas introduced.

Carbon and Carbon Dioxide

When carbonizing agents are based on the simple simultaneous action of carbon and carbon monoxide they will have a great speed of penetration in the carburized zone, great uniformity in the penetration of carbon in this zone, the peeling tendency will be largely overcome and there will be a greater possibility of pre-determining the percentage and depth of carbon that will be obtained within a given time. The gases can be controlled by diluting with nitrogen, by limiting the contact of the solid carbon with the surface of the steel, by varying the carbonizing temperature; and absolute security can be obtained against the introduction into the steel of any foreign substance other than carbon. The surface of the carbonized pieces can be much better preserved and the necessity of grinding and machining them afterwards overcome, and they can be prevented from becoming deformed and changed in volume. A large part of this is due to the fact that the carbonizing gas can be sent into the furnace in a continuous stream that can be regulated so the used gas will not exhaust until all of the carbon has been used up.

In conjunction with this latter gas process, compression has been used, and experiments already conducted have proved that characteristics of the carburized zone vary in proportion to the variation in the pressure of the carbonizing gases. The carbonizing gas was obtained by sending a slow current of carbon dioxide through a mass of wood charcoal in which the work was packed, in the same manner as in the latter furnace. When this gas was compressed in the carbonizing retort and the steel therein was maintained at a carbonizing temperature it was found that the increase of pressure increased the depth of penetration obtained within a given time, and also gave a more uniform distribution of the carbon within the carburized zone.

Of the solid carbonaceous substances, many materials have been tried. Some of these are: Charcoal, bone, horn, burnt sugar, charred leather, ferrocyanide, potassium cyanide, anthracite and graphite; and of gaseous substances: acetylene, petroleum, naphtha and gasoline. In various combinations with the above materials black oxide of manganese, ammonia, bicarbonate of soda, borax and other elements have been used. After much experimenting, it has been found that a mixture of bone and bone charcoal—the latter being a residue from previous operations—is without doubt as good a solid carbonizing material as can be obtained for steel. Thus, if 40 per cent. of new bone is added to 60 per cent. of the burnt bone taken from the boxes after carburizing, it will give as deep and rapid a penetration as any of the solid carbonizing materials. It will also give as good results as can be obtained with any combination of the various materials mentioned above, if not better.

New Exploitations of Old Processes

In the throwing out of useless materials and the elimination of those with a weak power for carburizing, chemistry with its great advances has performed a very useful labor for the steel industry. Notwithstanding this, however, the materials mentioned above are so numerous that every little while an attempt is made to impose upon the steel industry and machine manufacturers a special, new, secret compound that is heralded as a wonderful discovery. New developments like the gas processes are often used as an opportunity to promote such practices. Almost as far back as we can trace the steel business we find that the carbonizing process has been "faked," and it stands in the same relation to steel making that the gold brick does to the agriculturist. Periodical waves of such secret processes seem to traverse the country, and just at the present time there is another wave at its hight. Circulars are being received from various places which claim that low-grade steel, wrought iron or even cast iron can be changed into high-quality tool steels by some kind of roasting or baking process. A favorite scheme is to get manufacturers to make milling cutters or similar tools from wrought iron or machinery steel and then take them and convert them into tools that will nearly equal high-speed steel.

Cast iron, as is well known, contains from 3½ to 4 per cent. of carbon. To convert cast iron into steel it is necessary to remove at least one-half of the carbon. The days of the conjurer and alchemist being past, it is impossible to change this element into any other element. No method has been discovered by which this carbon can be removed from the iron without melting and boiling the metal and thus oxidizing it out, or else leaving the metal impregnated with cavities. Other impurities also have to be removed before this product can be made into a high-grade steel. Therefore, when any one claims to have a process that will transform cast iron into steel by baking it in an oven for a few hours, it is useless to waste any more time with him or give his process a second thought. It may seem idle to mention such claims, but it is not many months since I was in an office on Broadway in which such a proposition was being exploited. It had been promoted for a year previous to that in London and before that in Germany.

Cost Measures Impurities Removed

Wrought iron is the opposite of cast iron in one regard, *i. e.*, instead of containing more carbon than steel, it contains less. Usually the carbon is below 0.10 per cent. This product, therefore, can be carbonized so that the outer surface can be hardened and thus made brittle, while the inner core will be soft and non-brittle. In fact, wrought iron is made into blister bar, containing about 1.00 per cent. of carbon, by a carbonizing process. Wrought iron, however, contains a considerable percentage of slag, is not nearly as strong as tool steels and in no way can be compared to them in hardness, etc. To remove this slag takes materials and labor, and consequently wrought iron is cheaper than high-grade steel; especially is this so of tool steels, which have most of the impurities removed.

The same thing holds good of making machinery or low-grade steel into high-grade tool steel. The difference in price between high-grade and low-grade steels is due to the amount of labor or materials that have been used to remove the impurities. Low-grade steels contain high percentages of such injurious elements as phosphorus and sulphur, and these are reduced to low percentages in high-grade steel. Oxygen, hydrogen, nitrogen and other gases which may be segregated in large enough volume to form miniature blow holes, gas bubbles, etc., or present in the form of occluded gases have also proved to be very injurious elements in steels. No process has been discovered by which these can be removed from the metal without remelting it, even though it may have the carbon percentage increased by a baking process and thus made stronger.

We can take various complicated combinations of the different elements, reduce each element to a pure state and then weigh or measure it. We have also learned the affinity that one element has for another and how to bring different elements together when they have enough affinity to form compounds. Likewise, we know how to remove one or another of the injurious elements from complicated compounds.

Nowhere, however, in the history of the world has it been shown that it is possible to change one element into another, and until this is done we do not see how it is possible to transform metals in such a manner that any of the solid elements that are injurious can be removed from the metal without a remelting. To remove them from the solid metal would mean to create a void where they existed. This void would cause a break in the cohesion of the different molecules and thus cause a weakening of the mass. In fact, the impurities do that at the present time, and thus low-grade steels are weaker than high-grade steels.

Carbon is an element that flows in iron somewhat in the manner in which an electric current flows through a copper wire. Thus, if a steel plate containing 1.00 per cent. of carbon is attached to a plate containing 0.50 per cent., it is only a question of time when both plates will contain 0.75 per cent. of carbon. At atmospheric temperature this movement of the carbon is extremely slow, and hence not useful for any practical purpose. As the temperature is raised there is an increase in the speed of its travel, and when steel is heated to 1650 deg. F. it very readily absorbs carbon. Some of the other elements can be injected into steel in this manner, but they would have to be added to the elements that were already present in the metal and not change these into something else. Hence the metal would remain low-grade, even though it were made to resemble high-grade steel.

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CONTENTS.

A Dispatching System for Works Management 1
The Brinell Test for Automobile Steel 7
The American Brass Company 10
Plate and Merchant Mills at Haselton, Ohio 11
Iron and Steel Making in Texas 14
Peat Deposits in the United States 16
Gas Poisoning Among Iron and Steel Workers 16
Power Requirements of Rolling Mills 17
International Steam Pump Company 21
Notes on the Heat Treatment of Steel 22
System in the Lodge & Shipley Machine Shops 24
British Iron and Steel Exports and Imports 28
Record Coal Production in 1911 28
The Human Side of Business Organization 29
The Development of Alaska's Resources 29
Accident Prevention in Steel Plants 30
A Circular Saw Guard 40
Improvement in the Quality of American Steel 41
November Iron and Steel Exports and Imports 49
Iron and Steel Prices for Fourteen Years 50
Railroad Presidents on the Outlook 51
To Regulate the Handling of Explosives 51
Refrigeration Plant for Dry Air Blast 52
The World's Progress in Metallurgy 54
The Pittsburgh Iron Trade in 1911 57
The Chicago Iron Trade in 1911 59
The Philadelphia Iron Trade in 1911 60
The Copper Trade in 1911 62
The Sheet and Tin Plate Trades in 1911 63
The Cincinnati Iron Trade in 1911 64
Lake Superior Ore Developments 65
The Warren Tool & Forge Company 67
New Shearing Machine 68
Safety Limit Stop for Electric Cranes 68
Mayari Steel: Its Properties and Uses 69
The Sintering of Iron Bearing Materials 73
Making Mileage Recording Instruments 77
Baltimore Business Notes 80
The Carbonizing of Steel by the Use of Gases 81
Iron and Steel in 1911 and 1912 84
Steel Price Competition Less Formidable 85
The Proposed Reduction in Iron and Steel Duties 85
The Three Greatest Iron Producing Countries 86
The Efficiency Movement in 1911 87
Phillips Company Buys Pope Tin Plate Company 87
Upson Nut Company Transferred 88
Ingot Mold Trade an Index 88
Refrigeration Plant for Dry Air Blast 88
Pittsburgh and Vicinity Business Notes 88
The Machinery Trade in 1911 89
The Iron and Metal Markets 90
Personal 97
New Publication 97
New Iron and Steel Works Construction 98
The Dinner to Charles M. Schwab 102
The Central Tube Company 102
Obituary 102
Evansville Plant of the Bucyrus Company 103
The American 24-In. Lathe 109
Some Recent Mechanics' Tools 110
The Machinery Markets 111

Iron and Steel in 1911 and 1912

The conditions under which the iron trade enters upon 1912 are in favorable contrast in a number of ways with those at the opening of 1911. As indicating the viewpoint of one year ago and the prognosis for the unsatisfactory year which has just ended we quote as follows from what was said in *The Iron Age* of January 5, 1911:

Seldom has the iron trade entered upon a year more beset with uncertainties than is 1911. * * * For four months the shrinkage of new orders has been pronounced and the opening of the new year shows nothing near at hand to change that tendency. For the present the industry is involved with all others in a reactionary movement which seems not yet fully to have run its course. Railroad buying for this year, as far as outlined by railroad officers, does not promise much increase, if any, over that for 1910. * * * In addition to the influences which affect all industries, iron and steel products have to reckon with the result of the present deadlock over prices. It is the habit of consumers to buy on a rising market or because of the prospect of an advance. Such an incentive to buying is not now in sight, and manufacturers are not yet persuaded that prices should go down in order that later they may go up. The price situation, therefore, conspires with other factors to make the first half of 1911 a period of moderate demand. In general, the disposition among the leaders in the trade is to look for a reversal of the course of 1910, and thus to expect that conditions at the end of 1911 will be considerably more favorable than at the beginning.

What actually happened in 1911 was far from the thought of leaders in the trade when the year opened, yet what is quoted above shows plainly the feeling that the price situation was a problem that required in some way to be worked out. The way was found, but it was not such as the captains of the industry would have chosen. It was not more agreeable, in fact, than was the remedy that came unsought in October, 1907, for the excessive prosperity from which the country had been suffering for a good many months.

But 1911 has borne out the opinions expressed as it came in, that at its end the iron trade would be in better condition than at its beginning. There is a healthier basis to-day for a forward movement than by any possibility could have been laid in the deadlock over prices that existed one year ago. With all the trying experiences of the year, as detailed in the market reviews on other pages, steel manufacturers have found out some things about lowering costs that were not learned under price maintenance. The same old way of hard necessity has been traveled again, and there has been a general setting of the house in order for the low level of values that must prevail as long as there is more than 30,000,000 tons of steel making capacity and only demand for 23,000,000 to 25,000,000 tons of steel. With wages maintained in a way that has been without a parallel, mill managers were under a pressure they never knew before to get their costs down by increasing efficiency. The year's record in this respect is notable.

Another service done the industry in 1911 was the elimination of the $1 royalty for Lake Superior iron ore. The notice to cancel the Great Northern ore lease formally marked the end of the scare over an iron ore shortage and paved the way for the alignment of iron ore values with prices prevailing at the other end of the industry.

As the new year opens some of the published comments on iron trade conditions, particularly those emanating from Pittsburgh, are well-nigh buoyant. Some few price advances have been made from the lowest, as the mills have been filled up for some months ahead by anticipatory buying at the bargain

level, and there have been cautions against getting prices up too fast. But there is far less danger of conditions improving too fast than of having the actual improvement overestimated. The large orders now on the books of the mills give little to boast of except as they become the foundation of a profitable business later. The most encouraging feature in the situation is the evidence that to an extent business has outworn the fear of political damage and is convinced that what it is yet to feel from legislative action cannot be more harmful than the long overhanging threat. The hopes of steel manufacturers are built largely on four years of starveling consumption by the railroads, the average rate in that time being less than 50 per cent. of that for 1905, 1906 and 1907. But, while they look for greater activity in 1912 than in 1911, they do not forget two things: First, that manufacturing capacity in iron and steel and in all other lines is excessive; second, that steel trade booms have always sprung from a large demand for equipment for new plants and extensions, and that there is no probability of the reappearance of such a demand in 1912.

Steel Price Competition Less Formidable

Steel manufacturers scrutinizing their small profit accounts in the closing months of 1911 will hardly subscribe to the sentiment that "familiarity breeds contempt" for competition in the steel trade. Rather they will profess a wholesome respect for it and the important results which it produces. At the same time, the "menace of destructive competition" after the experience of the past few months does not appear altogether in the light in which it was pictured at earlier times.

Some of the presentations referring to "destructive competition" based their argument on a period in the iron and steel business when forces were at work which were quite apart from competition between manufacturers. Conditions existed which were necessarily destructive of values represented in plant investment, and a return to a competitive market would not duplicate those conditions as to manufacturing processes. The "lessons" were drawn from various experiences in the nineties. It is true that there was competition, and very sharp competition, during much of that period, but it is also true that the iron and steel trade was passing through a revolution in processes. While the Bessemer steel making process was introduced on a large scale in the seventies, and had still greater vogue in the eighties, it was distinctly in its early years a process for the manufacture of rails. The product did not to any great extent enter into competition with wrought iron. As late as 1890 we find that more than half of the finished steel made in the United States was in the form of rails. The destruction of iron rail mills by the Bessemer rail mills had been completed, while the growth in consumptive demand for wrought products other than rails had been so great—pig iron production increased 63 per cent. in the five years ended with 1890—that the iron mills were not seriously injured by the advent of the limited tonnage of soft steel products. The iron mills in certain lines were doomed, for Bessemer steel was better and cheaper than wrought iron, but the doom was not executed until a decline in total demand followed a rapid expansion. In the nineties there was much plant destroyed by competition, but the competition was much more the competition of processes than it was the competition of men.

Pictures of the evils of destructive competition have an error of perspective or proportion when they suggest the establishment of monopoly as the quick and certain result of destructive competition, because they do not make proper allowance for two vital factors: 1. The continued growth in consumptive demand. 2. The enormous capital requirements, particularly in these times, involved in increasing capacity. Defense of the criticism that these pictures are lacking in proportion can obviously be made only by citing actual figures, so as to illustrate proportions, and as the old Carnegie Steel Company has often been mentioned in this connection its case may be used. In 1900, its last year of independent existence, it made about 2,500,000 tons of steel ingots. The total production of steel ingots and castings in the United States increased from 10,188,329 tons in 1900 to 26,094,919 tons in 1910, thus being multiplied by two and one-half in a decade. Obviously the possibility of the Carnegie Steel Company making any headway at destroying its competitors during such a decade would be very remote. To eliminate competitors and meet the increased demand, which demand would hardly have grown less rapidly under lower prices, it would have been necessary for the Carnegie capacity to have been multiplied by 10 in a period of 10 years, impossible except with truly terrific profits.

Similar reasoning would not, of course, necessarily apply for the future. During a period of steadily increasing demand, with prices allowing all producers to live, and in a later period of declining or stationary demand it might ultimately come to dominate or control, but regard must be had for the proportion of things.

The position to-day is that lately demand has been less than capacity, but the gap is no larger than the normal increase in demand will bridge in a very few years. The state of the art is such that the existing plant cannot be made worthless in a short time, as occurred with so many iron mills and their attendant facilities in the nineties, and the capital requirements for increasing productive capacity have become so large that new capacity cannot hope readily to dispossess older capacity which is itself quite modern. Now and then some plant may fall by the wayside, but with the steady increase in demand and the enormous capital involved important displacement of this sort is quite improbable, even though the market should remain on a keenly competitive basis.

The Proposed Reduction in Iron and Steel Duties

The announcement is made that the Democratic leaders of the House of Representatives have decided to take up the revision of the tariff duties on iron and steel at an early day. The bill is said to have been completed and only awaits official action by the Ways and Means Committee. Report has it that duties are to be reduced 30 to 40 per cent.

It is to be hoped that the reductions proposed will not be too drastic. While at present our prices of numerous steel products are below those prevailing in Europe, and therefore the proposition to reduce duties is not so disturbing as it would be if conditions were the opposite, yet the fact cannot be overlooked that existing American prices are not only unremunerative for producers of steel commodities but for no inconsiderable number of them are actually below cost. European steel manufacturers are now enjoying an unprecedented demand and their prices are higher than

ours only for the time being. With the decline of their prosperity, which is surely to be expected, they will turn to this country in the hope of finding a market for a part of their surplus. If our duties are too low they will be able to capture business along the Atlantic seaboard and the Gulf and Pacific coasts, to the detriment of our manufacturers and their workmen. The German steel manufacturers, in particular, would become annoying competitors in our market, their practice of paying a bounty on exports enabling such obstacles as a low tariff duty and freight rates to be easily overcome. To meet such a contingency the level of American steel prices would have to be reduced below even the lowest depth attained in the depression of the past year. This would mean a readjustment of costs of all raw material, transportation and labor.

The Three Greatest Iron Producing Countries

The great activity now prevailing in the European iron trade and the reawakening in this country make some comparison of the three greatest iron producing countries timely. These three countries are the United States, Germany and Great Britain. No other country is in their class, the fourth in order of production being France, whose rate of output falls far below the lowest of these three. Taking pig iron as the basis of comparison, and including Luxemburg with Germany, the production of the three leading nations has been as follows for the past 30 years:

Production of the Three Greatest Iron Producing Countries for 30 Years.

Years.	United States. Gross tons	Germany. Metric tons	Great Britain. Gross tons
1882	4,623,323	3,380,806	8,586,680
1883	4,595,510	3,469,719	8,529,300
1884	4,097,868	3,600,612	7,811,727
1885	4,044,526	3,687,434	7,415,469
1886	5,683,329	3,528,657	7,009,754
1887	6,417,148	4,023,953	7,559,518
1888	6,489,738	4,337,121	7,998,969
1889	7,603,642	4,524,558	8,322,824
1890	9,202,703	4,658,450	7,904,214
1891	8,279,870	4,641,217	7,406,064
1892	9,157,000	4,937,461	6,709,255
1893	7,124,502	4,986,003	6,976,990
1894	6,657,388	5,380,039	7,427,342
1895	9,446,308	5,464,501	7,703,459
1896	8,623,127	6,372,575	8,659,681
1897	9,652,680	6,881,466	8,796,465
1898	11,773,934	7,312,766	8,609,719
1899	13,620,703	8,143,133	9,421,435
1900	13,789,242	8,520,540	8,959,691
1901	15,878,354	7,880,087	7,928,647
1902	17,821,307	8,529,900	8,679,535
1903	18,009,252	10,017,901	8,935,063
1904	16,497,033	10,058,273	8,693,650
1905	22,992,380	10,875,061	9,608,086
1906	25,307,191	12,292,819	10,109,453
1907	25,781,361	12,875,159	9,923,856
1908	15,936,018	11,805,320	9,056,851
1909	25,795,471	12,644,946	9,531,987
1910	27,303,567	14,227,455	10,216,745
1911 (Est.)	23,750,000	15,400,000	10,250,000

As German statistics are given in metric tons, and the difference between a metric ton of 2204 lb. and our gross ton of 2240 lb. is slight, the official German figures are preserved in this table.

Taking the table as a whole, the most striking points are: 1. The rapid growth of the production of the United States. 2. The slower but continuous growth of the production of Germany. 3. The comparatively stationary rate of production of Great Britain. Production in the United States has advanced by leaps, occasionally falling back for a year or two, and then advancing with another great leap. Germany's growth, while slower, has been of marked steadiness, as only 4 years of the entire 30 have shown a falling off from the preceding year. It took 15 years, from 1882 to 1897, for Germany to double its annual production, and 13 years, from 1897 to 1910, to double it again. The growth of the production of the United States, however, while far more rapid than that of Germany, has been much more spasmodic. In no less than 10 years of the 30 was the output smaller than that of the preceding year. Yet it took only 8 years, or from 1882 to 1890, for the United States to double its output, and in 13 years, or from 1890 to 1903, it was practically doubled again. It may be remarked, in passing, that the steel production of these countries has kept a close relation with their output of pig iron.

It will be observed that 30 years ago, in 1882, Great Britain was in the ascendancy, producing more pig iron than the United States and Germany combined. But 1884 was the last year in which she enjoyed this distinction. Her production in 1882 was the maximum for a long series of years, not being equaled or exceeded until 1896, and it was not until 1906 that she entered the 10,000,000-ton class.

While the United States was the second iron producing country when Great Britain was first, in 1890 the younger nation came to the front, then alternated with its competitor for a few years until in 1897 it took first place permanently. Great Britain then ranked second until 1903, when Germany left her far in the rear. The growth of production in this country has been so rapid that since 1901, with the exception of 1903, 1904, 1908 and 1911, all years of depression, its output has been far in excess of the combined output of Great Britain and Germany.

In this connection many of our readers will doubtless be interested in statistics for the 30 years ended with 1910 of our imports and exports of pig iron. They are given in the following table, with which the figures of production are also presented for the purpose of arriving at the apparent annual consumption, it being impossible to show the actual consumption because statistics of stocks are available for only a portion of the period covered.

Apparent Consumption of Pig Iron in the United States, Gross Tons.

Years.	Production	Imports	Exports	Apparent consumption
1881	4,144,254	465,031	6,158	4,603,127
1882	4,623,323	540,159	5,576	5,157,906
1883	4,595,510	322,648	3,768	4,914,390
1884	4,097,868	184,269	3,831	4,278,306
1885	4,044,596	146,740	6,228	4,185,108
Average, 5 years..	4,301,110	331,769	5,112	4,627,767
1886	5,683,329	361,768	8,849	6,036,248
1887	6,417,148	467,522	6,796	6,877,874
1888	6,489,738	197,237	14,364	6,672,611
1889	7,603,642	148,759	13,573	7,738,828
1890	9,202,703	134,955	16,341	9,321,317
Average, 5 years..	7,079,312	262,048	11,985	7,329,375
1891	8,279,870	67,179	14,946	8,332,103
1892	9,157,000	70,125	15,427	9,211,698
1893	7,124,502	54,394	24,587	7,154,309
1894	6,657,388	15,582	24,482	6,648,488
1895	9,446,308	53,232	26,164	9,473,376
Average, 5 years..	8,133,014	52,102	21,121	8,163,995
1896	8,623,127	56,272	62,071	8,617,328
1897	9,652,680	19,212	262,686	9,409,206
1898	11,773,934	25,152	253,057	11,546,029
1899	13,620,703	40,393	228,678	13,432,418
1900	13,789,242	52,565	286,687	13,555,120
Average, 5 years..	11,491,937	38,719	218,636	11,312,020
1901	15,878,354	62,930	81,211	15,860,073
1902	17,821,307	619,354	27,487	18,413,174
1903	18,009,252	599,574	20,379	18,588,447
1904	16,497,033	79,500	49,025	16,527,508
1905	22,992,380	212,466	49,221	23,155,625
Average, 5 years..	18,239,665	314,765	45,465	18,508,965

Years.	Production	Imports	Exports.	Apparent consumption
1906	25,307,191	379,828	83,317	25,603,702
1907	25,781,361	489,475	73,703	26,197,133
1908	15,936,018	92,202	46,696	15,981,524
1909	25,795,471	176,442	61,989	25,909,924
1910	27,303,567	237,233	127,385	27,413,415
Average, 5 years..	24,024,721	275,036	78,618	24,221,139

In the 5-year period, 1886-1890, our pig iron consumption increased over 58 per cent. In the 5-year period, 1891-1895, it increased but 11 per cent., as 1893 to 1895 were years of severe depression. In the 5-year period, 1896-1900, it increased over 38 per cent. In the 5-year period, 1901-1905, it increased over 63 per cent., this period showing the largest increase in our history. In the 5-year period, 1906-1910, it increased over 30 per cent.

In the 30 years embraced in the period from 1882 to 1911, inclusive, the three greatest iron producing countries contributed to the world's supply of pig iron the stupendous aggregate of 861,763,413 gross tons, of which the United States furnished 385,954,475 tons; Great Britain, 254,742,429 tons, and Germany, 221,066,509 tons, the German figures being converted from metric to gross tons in this instance. We leave to others the opportunity of theorizing as to how much of this iron in the form of scrap is likely to figure in meeting the world's requirements for raw material in coming years.

The Efficiency Movement in 1911

A review of the industrial progress of the past year must take account of the influence of the widespread publicity accorded to questions of efficiency in general and scientific management in particular. The great impetus given to thought on these matters by the hearings before the Interstate Commerce Commission in the protest of the shippers against proposed increases in freight rates by the railroads brought into print a mass of discussions, good, bad and indifferent, which have appeared in practically every newspaper and periodical in the country.

The gospel of efficiency and scientific management was preached in various ways by its different apostles. Some particular creed or tenet presented a peculiar appeal to some editor and he would lay stress on that particular phase of the question, and the result is that individual members of the general public as a rule mistake parts for the whole. Some of them see only time, method and motion study; some see only functional management; others only system, etc.

What is true of the magazine and newspaper publications is also true of the books of the year. In order to get a comprehensive view of the situation, one needs to read many books. If there is to be any general criticism made of the books published it is that while they are replete with general principles and examples of application to specific plants, they do not as a rule present what is applicable and what is not applicable to certain classes of industries and certain types of plants. If there are any exceptions to be made to this general rule, they are the books on "Industrial Plants" by Day and "Principles of Industrial Engineering" by Going. Mr. Day confines himself to the question of general principles of factory planning and shows how efficiency in factory planning can only be brought about by considering the essential differences between different types of plant. Mr. Going has made an excellent presentation of the field to be covered by the industrial engineer, but a reader cannot help feel that the general treatment accorded to specific topics could, with great advantage, have been made to include a treatment of topics along the same line equally relevant and essential.

The conference on scientific management held at Dartmouth College under the auspices of the Tuck School of Business Administration last October was one of the important results of the movement. This conference was attended by some 300 representative men, including men in mercantile business, presidents of railroads, textile, leather and paper industries, as well as company officers and consulting engineers who had already developed a considerable science in the metal trades. A notable feature of this conference was that it was participated in not only by company officials and consulting engineers, but by a number of college instructors and by several foremen and superintendents of factories. The only regret the writer had was that there was no representation of organized labor at the conference, since such representation could only have been productive of a better mutual understanding.

The forming of a national society for the study of the problems connected with efficiency and scientific management on December 4 in New York City must also be mentioned as one of the year's developments. This society, while appreciating the work of the engineer in the field of production, realizes that it should recognize the work of men outside of the engineering profession who have been instrumental in furthering efficiency in financing, efficiency in general accounting, efficiency in selling and efficiency in general business administration.

In the educational field it is a noteworthy fact that many of the technical colleges are beginning to realize that education for factory management, while fundamentally an engineering problem, must include a broader training than is offered merely by preparation for machine designing and engine testing. We are beginning to realize that although we must give great credit and a rightful place to machinery invention and the development of power generating devices, the industrial manager has to cope with other economic factors equally as important, if not more so. The writer ventures to say that further recognition will be given by colleges and universities within the next few years to the more inclusive field of industrial engineering than has hitherto been accorded to it. The schools of business administration have developed courses in general accounting, insurance, banking, transportation and consular service, but have not treated in an inclusive, comprehensive way, the field of manufacturing. The past year's agitation has brought home to many educators the realization of this fact.

Among the industries we find a decided tendency toward introspection or self-study, accompanied by a considerably increased demand for the service of professional engineers and accountants. With the increased demand for such services, we must expect that services will be offered by persons incapable of accomplishing desired results, a condition which may in individual cases cause a reactionary tendency.

The attitude of organized labor has thus far not been friendly to the movement. It is noteworthy, however, that the attitude of labor in plants where scientifically correct improvements have been installed is decidedly friendly. The favorable attitude of the working-men at the Watertown Arsenal, in spite of the heavy pressure brought to bear on them, is notable in this connection.

Among the railroads we find a welcome change from the early hostility shown toward any creed brought out by the witnesses testifying before the Interstate Commerce Commission. Some railroad officials have been annoyed by the professional efficiency engineer, as a result of the Interstate Commerce Commission hearings, and for this they are not to be blamed. On the other hand, the same spirit of self-study already mentioned is being manifested, as is evidenced by railroads calling on successful managers of industrial plants to address conventions of railroad engineers and employees and to present some phases of efficiency efforts in which these managers have been particularly successful.

HUGO DIEMER.

Phillips Company Buys Pope Tin Plate Company

The Phillips Sheet & Tin Plate Company, operating a tin plate and sheet mill plant at Clarksburg, W. Va., with 12 hot mills, and a tin plate plant at Weirton, W. Va., having 20 hot mills, has purchased the plant of the Pope Tin Plate Company at Steubenville, Ohio, containing 12 hot mills. This purchase gives the Phillips Company a total of 44 hot mills, consisting of 6 sheet and 38 tin mills, making it very much the largest independent tin plate producer in the country. Negotiations had been on for some time.

Nash, Isham & Co., pig iron, 55 Liberty street, New York, have dissolved partnership by mutual consent. Albert L. Nash will enter the firm of Crocker Bros. Phillips Isham will continue the business under his own name at 55 Liberty street and will liquidate the affairs of the old firm.

The Norton Iron Works, Ashland, Ky., blew out its Norton furnace December 20.

Upson Nut Company Transferred

The formal transfer of the plants and assets of the Upson Nut Company to a new Ohio corporation bearing the same name and controlled by the Bourne-Fuller Company, Cleveland, Ohio, took place January 2. The old Upson Nut Company, which operated under a Connecticut charter, will pass out of existence as soon as its affairs are wound up. The new Upson Nut Company's organization will be completed this week. Four members of the board of directors have so far been elected, namely, B. F. Bourne, H. A. Fuller, C. W. Bingham and William G. Mather. Three additional directors will be chosen, one of whom will be W. A. Hitchcock, who succeeded the late Andrew S. Upson as president of the Upson Nut Company. Officers have been elected as follows: H. A. Fuller, president; B. F. Bourne, treasurer; N. J. Clark, secretary. Mr. Hitchcock will be elected vice-president and will have charge of the company's plant at Unionville, Conn. Mr. Clark has been with the Bourne-Fuller Company 15 years and for several years past has been in charge of that company's Pittsburgh office.

The Bourne-Fuller Company has increased its capital stock from $150,000 to $2,000,000 to provide additional capital for acquiring the Upson properties. The new Upson Nut Company will have a capital stock of $6,200,000. Of this $1,200,000 will be in preferred stock and $5,000,000 in common stock. All the common stock will be held by the Bourne-Fuller Company. The offices of the Upson Nut Company will be moved shortly from their present location in the Garfield Building, Cleveland, to the Hickox Building, where the offices of the Bourne-Fuller Company are located.

The Upson properties acquired by the Bourne-Fuller Company include a blast furnace, four 60-ton open-hearth furnaces, a blooming mill and merchant mills in Cleveland and bolt, nut and rivet plants in Cleveland and in Unionville, Conn.

The Bourne-Fuller Company has long been a prominent iron and steel firm in the Central West, being a jobber in iron and steel, pig iron and coke.

Of the officers of the new Upson Nut Company, B. F. Bourne is president and H. A. Fuller is vice-president of the Bourne-Fuller Company. William G. Mather, one of the directors of the new Upson Nut Company, is president-treasurer of the Cleveland-Cliffs Iron Company, miner of iron ore and maker of pig iron, Cleveland, and is largely interested in other industries in that city. C. W. Bingham is president of the W. Bingham Company, wholesale and retail hardware, Cleveland.

Ingot Mold Trade an Index

The American Metal Market says: An excellent index or barometer of steel making conditions has been found to be the ingot mold trade, and current reports from this industry are that buying has been very heavy, with shipments large and prospects of their continuing so for some months. The steel mills buy molds in accordance with their prospects of steel production, as each mold averages a certain life in tons of steel cast. There is rarely a question about price in ingot molds, they being generally sold at a fixed differential above Bessemer pig iron, from which they are made. Usually they are billed at the average price of Bessemer pig iron, though occasionally a buyer wishes to have his molds for a given period at a flat price, and then the mold foundry covers on a corresponding tonnage of Bessemer iron for the delivery at such flat price as can be secured.

Fire destroyed a large warehouse at the plant of the Maryland Steel Company, Sparrows Point, Md., December 28. The building was used mainly for the storage of patterns, many of which were obsolete and will not be replaced.

The Marting furnace of the Marting Iron & Steel Company, Ironton, Ohio, which has been out of blast since November for repairs is expected to be blown in early in January.

The Elwood Ivins Tube Works, Oak Lane, Philadelphia, Pa., has added a new product, seamless chrome steel tubes, which are used very largely for roller bearings.

Refrigeration Plant for Dry Air Blast

[Continuation from p. 54, of the article by James Gayley on Improved Methods of Securing Dry Air for Blast Furnaces.]

A noticeable reaction is taking place abroad against the general use of high blast temperatures. It is observed that certain ores do not work as well in the furnace and the metal is not so readily held to the required grade as with lower heats. This appears to be the case more particularly with respect to hematites, which compare with our Lake ores. Similar results have been observed in our own practice. In some furnaces the range of heats employed has been lower than what the stoves would provide, and it was found necessary to control the metal within narrower limits.

No matter what the conditions are, it has been found that a furnace will work well with dry air, which provides at all times in a usable way the equivalent of high blast heats plus the economy due to eliminating a certain weight of moisture. Moreover, this greater advantage can be secured through the same expenditure required to provide just the high heats; besides, with dry air there is a large saving in the consumption of stove gas, which can be applied to power generation. Dry air also enables the furnace to work with less slag volume, which is economical.

Pittsburgh and Vicinity Business Notes

George J. Hagan, People's Bank Building, Pittsburgh, has received a contract from the Whitaker-Glessner Company, Wheeling, W. Va., for six stoker-fired Bailey patent combination sheet and pair furnaces to be installed in its plant at Martins Ferry, Ohio. This plant, which has six hot mills, is being extensively repaired.

The steel car plant of the Standard Steel Car Company at Butler, Pa., offices in the Frick Building, Pittsburgh, is being operated to full capacity, with work ahead for the next three months. This company also has a steel car works at South Baltimore, Md., which is turning out a large order for the Chesapeake & Ohio Railroad.

The Esswein Company, Columbus, Ohio, heating engineer, has received a contract for furnishing the tandem compound engines, heaters, etc., for installation in the Lima State Hospital, Lima, Ohio.

The Skinner Engine Company, Diamond Bank Building, Pittsburgh, has received an order for a 100 hp. engine to be direct connected to a generator to be installed in the crucible steel works of the Braeburn Steel Company, Braeburn, Pa.

The New York, New Haven & Hartford Railroad has placed an order with the Westinghouse Electric & Mfg. Company for 15 additional 1500-hp. electric locomotives. They are of the articulated truck type, 113 tons weight and will be equipped with HB unit switch control. This makes a total of 75 locomotives ordered by the New Haven road.

The American Steel Company, Park Building, Pittsburgh, Pa., has purchased the plant of the McCrorey Wire Nail Company at Ellwood City, Pa. The plant at present contains 15 to 20 wire nail machines, but the number is to be enlarged to 80 and in time to 160. A full line of cement coated nails for all purposes will be made.

The W. P. Snyder & Co. interests, Oliver Building, Pittsburgh, operating five ore boats on the Lakes, have made a traffic arrangement with the Carnegie Coal Company, Pittsburgh, to carry all of its coal next year destined for upper Lake ports. Last season it shipped about 600,000 tons of coal and the arrangement thus assures the Snyder ore fleet cargoes going the other way.

The Adirondack Electric Power Corporation has been incorporated in New York with $12,000,000 authorized stock, of which $2,500,000 is 6 per cent. preferred, as successor of the Hudson River Electric Power Company and allied companies recently foreclosed. As already announced, the Stone & Webster management association, of Boston, has agreed to act as manager of the new company. The officers of the new company are: President, James R. Hooper, Boston; vice-president, Charles E. Willock, Pittsburgh; secretary, Francis M. Edwards, Boston; treasurer, William H. Blood, Jr., Boston. The company has applied to the Public Service Commission for permission to issue $9,000,000 common and $2,500,000 preferred stock and $5,000,000 50-year 5 per cent. bonds.

The Machinery Trade in 1911

The year 1911 in the machinery trade was a very moderate one. It has been exceedingly irregular, and, as between individual houses, the fluctuations of demand have been by no means uniform. As compared with 1910, business showed a considerable falling off, but the year terminated with some actual improvement, and, according to the general estimate, with a good deal of promise.

A comparison between 1910 and 1911 is shown in the accompanying chart. It represents the experience of a typical business of moderate size, manufacturing standard machine tools, special machinery and gray iron castings, so that the totals of its books include three distinct and very representative influences. While similar curves plotted from the books of other machinery builders would probably show variations as to months and seasons, when compared with this chart and with one another, the average of the 1911 line in its relations to that of 1910 would not be relatively very different. With one large machinery builder the fluctuation in business during the eleven months ended December 1 is represented by months by the following figures: 41, 33, 56, 31, 39, 27, 28, 25, 27, 41, and 33; the sales averaging 60 per cent. of the two years preceding. With a few other machine tool manufacturers the percentage is somewhat higher.

Foreign orders constituted a very important part in the year's totals, being considerably in excess of 1910. This foreign demand and the automobile industry were the great favorable factors; without them the depression in the machinery market would have been somewhat serious.

Demand for Machinery to Reduce Cost

The demand, both domestic and foreign, has been confined largely to those classes of machinery which either effect large savings in production cost through increased output or which eliminate to a greater or less extent the necessity for skilled mechanics. In many cases, of course, both of these elements are included in one machine. An evolution has been in progress among buyers in respect to their requirements for a number of years, because of their recognition of the economies resulting from better machinery. In 1906-7 the newer types were not so well known as they are to-day. When business was at the top notch their enormous value wherever they were installed taught a lesson which has been accepted very generally.

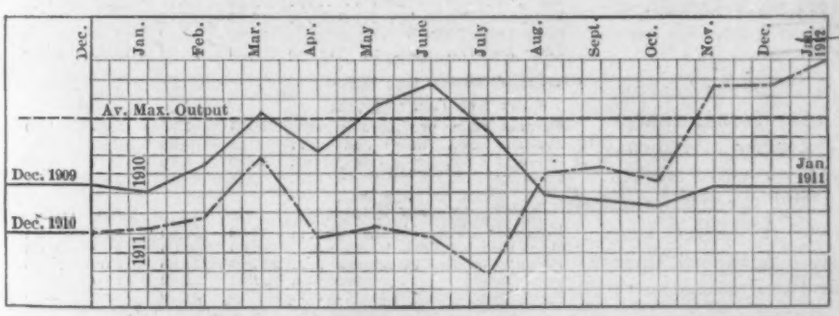


Chart Showing Machinery Sales by a Representative Company in 1911 Compared with 1910

In the period of dull and moderate business which has intervened, a vast amount of reorganization of shop equipment and methods has been effected. Millions of dollars in specifications for new machinery, which have been sanctioned, but which have been held up by financial considerations are included in the planned reconstruction. Orders from these sources are beginning to be placed—in practically every case under condition of immediate shipment. New business is confined almost entirely to special and semi-special machinery, and the newest types of high-power, high-speed and standard tools. This will play a steadily increasing part in its relation to the products of machinery builders.

The one notable exception to this is the average railroad. This class of customer often intends to purchase the very best machines for the various purposes of the repair shop; but the intention is that of the engineers who design the installation rather than that of the powers who govern the purchases. The outcome is the substitution of cheaper equipment for reasons of price or other influences.

The Lack of Skilled Labor

Skilled labor constitutes the most serious menace in the machine shop. Men who are being trained in this field are numerically far less than the increase in demand which is constantly being experienced. Even to-day, when the machine shops of the country are running at reduced capacity, really good workmen are not readily found. The same condition which existed in 1907 will be felt in an accentuated form when full forces are required everywhere. It is no wonder, then, that ordinarily far-sighted owners are seeking to secure efficiency in their works by the aid of equipment which shall replace a first-class machinist.

With the exception of the automobile industry, most lines which require machine tools to produce their work have not been busy, though many works have had a moderate volume of orders, and, in some cases where special industries are served, full capacity has been averaged in the year. It is impossible to give the detailed experiences of the different branches of machinery manufacturing, because, even where lines are very similar, the variation has been marked. In practically every case it has been a year of sudden ups and downs.

"A Comparative Study of Wage and Bonus Systems," a pamphlet of 27 pages by Harrington Emerson, is published by the Emerson Company, New York, with a view to correcting the "widespread misconception of the distinguishing features of various wage and bonus systems." By means of graphic charts the Halsey, Rowan, Taylor, Gantt and Emerson systems of rewarding efficiency of labor are compared.

A committee of the anthracite mine workers of Pennsylvania has been appointed to present the demands of the men to the operators. The demands which they will make include these: A 20 per cent. increase in wages, a reduction of the nine-hour day to eight without reduction in wages, the abolition of the Conciliation Board created by the Strike Commission in 1903 to adjust disputes, payment for coal by weight instead of by carload, the recognition of the union, collection by the coal companies of union dues from employees and several minor concessions. The present three-year contract does not expire until March 31, and it will probably be close to that time when the operators' reply is given. In the meantime both sides are preparing for a strike.

The huge dam which the Cleveland-Cliffs Iron Company has had under construction on Carp River, Michigan, in the past six months is fast nearing completion. The concrete work is finished. The pipe line, six miles in length, is in place, and the riveting is in progress. The power house at Marquette, Mich., is enclosed and the machinery is being installed. It probably will be March 1 before the plant will be in steady operation. The transmission line is in readiness, and as soon as electricity is made at Marquette it will be carried to the different iron mines of the company. The plant will develop 7500 h.p. It is costing more than $1,000,000.

Edward Hickey, of Ishpeming, Mich., the United States Steel Corporation's oldest employee on the Marquette iron range, gave up work this week, having reached the age of 70, and his name will be placed on the company's pension list. He entered the employ of the Lake Superior Iron Company, now a Steel Corporation subsidiary, in 1864, taking a position as a miner in the old No. 2 open pit, where he has been employed almost continuously ever since. His period of service thus has been 47 years, the most of that time as a foreman.

In an interview in Montreal, J. H. Plummer, president of the Dominion Iron & Steel Company, said that his company has now on its books orders for about 150,000 tons of rails. As to rods, he says there are orders enough to keep the mill running till June.

The Iron and Metal Markets

Larger Steel Output

Additional Mills and Furnaces Active

Pig Iron Production in 1911 Is Estimated at 23,750,000 Tons

Reports from the Pittsburgh district indicate that the increased activity at blast furnaces and steel plants due to the business stimulated by bargain prices in December is centered there. The Carnegie Steel Company is conspicuous in the movement. Two Edgar Thomson furnaces which have been banked for some time are again in blast, and these, with the resumption of one New Castle and two Ohio stacks at Youngstown, make an addition of five to the company's active list. The starting of three or four additional furnaces in the near future has been under consideration.

Independent steel companies enter the new year with their schedule of operations little changed, though the largest of such companies in the Pittsburgh district is starting up new steel-making capacity this week and the rail mill at Sparrows Point has resumed after being idle for some weeks.

No small part of the orders for finished steel products closed in the final week of 1911 were brought in by the expiration of the time limit on numerous quotations made on the old low basis.

Pig iron buying in the Central West has kept up on a scale indicating that a good many foundries kept out of the November and early December movement. Cleveland and Cincinnati both report an active market for deliveries in the first quarter and the first half, malleable interests having taken on good-sized lots. Two large Southern producers have advanced their price for No. 2 foundry for the first half to $10.50 at Birmingham, but $10 iron is still offered.

The eastern Pennsylvania pig iron market has developed more inquiry and actual buying than in a good many weeks. Virginia irons have been particularly active there. One Philadelphia steel company is in the market for 3000 tons of Bessemer, 2000 tons of basic and 3000 tons of low phosphorus iron.

Production of foundry iron has increased slightly by the blowing in of several furnaces in December and a few scattering additions to the producing list are scheduled for early January.

While only partial returns from the blast furnaces are available at this writing (January 2), we estimate pig iron production in 1911 at 23,750,000 tons, which compares with the high record of 27,303,000 tons in 1910 and with 25,795,000 tons in 1909. But stocks at furnaces were reduced in 1911, probably by 400,000 tons, whereas in 1910 there was an increase of 1,000,000 tons or more.

Estimates of the New York Central and Pennsylvania Railroad rail orders are not as high as those current earlier, the former being now put at 180,000 tons and the latter at 135,000 tons. The Tennessee Company has the Southern Railway's order for 22,000 tons and the Minnesota, Dakota & Western has placed 2000 tons. The Canadian Pacific is in the market for 3100 tons.

In the structural branch of the trade volume is maintained both in buildings and bridges. In the New York district 15,000 tons was closed last week in addition to the 40,500 tons in the contract for bridge and viaduct approaches of the New York Connecting Railroad. Bids have been opened on 7000 tons for the Michigan Central depot at Detroit, but the contract awaits that for 3000 tons for train sheds, to be let this week.

Line pipe buying has started well in the new year. The National Tube Company has the contract for 124 miles of 12-in. pipe for the Southern Gas Company of California. There is also an order for 30 miles of 8-in. pipe for the Texas Company and one for 8 miles of 8-in. pipe for McAlester, Okla.

A Comparison of Prices

Advances Over the Previous Week in Heavy Type, Declines in Italics.

At date, one week, one month and one year previous.

	Jan. 3, 1912.	Dec. 27, 1911.	Dec. 6, 1911.	Jan. 4, 1911.
PIG IRON, Per Gross Ton:				
Foundry No. 2 standard, Philadelphia	$14.85	$14.85	$14.85	$15.50
Foundry No. 2, Valley furnace	13.00	13.00	13.00	13.75
Foundry No. 2 Southern, Cincinnati	13.25	13.25	13.00	14.25
Foundry No. 2, Birmingham, Ala.	10.00	10.00	9.75	11.00
Foundry No. 2, at furnace, Chicago*	14.00	14.00	14.00	15.50
Basic, delivered, eastern Pa.	14.25	14.25	14.50	14.75
Basic, Valley furnace	12.25	12.25	12.25	13.25
Bessemer, Pittsburgh	15.15	15.15	14.90	15.90
Gray forge, Pittsburgh	13.40	13.40	13.40	13.90
Lake Superior charcoal, Chicago	16.00	16.00	16.50	18.00
COKE, CONNELLSVILLE, Per Net Ton, at Oven:				
Furnace coke, prompt shipment.	**1.85**	1.75	1.50	1.40
Furnace coke, future delivery	1.65	1.65	1.60	1.75
Foundry coke, prompt shipment.	**2.00**	1.90	1.90	1.90
Foundry coke, future delivery	2.15	2.15	2.10	2.25
BILLETS, &c., Per Gross Ton:				
Bessemer billets, Pittsburgh	20.00	20.00	19.00	23.00
Open hearth billets, Pittsburgh	20.00	20.00	19.00	23.00
Forging billets, Pittsburgh	**27.00**	26.00	24.00	28.00
Open hearth billets, Philadelphia	22.40	22.40	21.40	25.40
Wire rods, Pittsburgh	24.50	24.50	25.00	28.00
OLD MATERIAL, Per Gross Ton:				
Iron rails, Chicago	14.75	14.75	14.50	15.50
Iron rails, Philadelphia	16.00	16.00	15.50	17.00
Car wheels, Chicago	13.25	13.25	12.75	13.00
Car wheels, Philadelphia	12.50	12.50	12.00	13.00
Heavy steel scrap, Pittsburgh	12.50	12.50	12.25	13.50
Heavy steel scrap, Chicago	10.50	10.50	9.75	11.50
Heavy steel scrap, Philadelphia	12.25	12.25	12.00	12.50
FINISHED IRON AND STEEL, Per Pound to Largest Buyers:	Cents.	Cents.	Cents.	Cents.
Bessemer rails, heavy, at mill	1.25	1.25	1.25	1.25
Iron bars, Philadelphia	1.27½	1.27½	1.22½	1.32½
Iron bars, Pittsburgh	1.25	1.25	1.20	1.35
Iron bars, Chicago	1.15	1.15	1.15	1.30
Steel bars, Pittsburgh	1.15	1.15	1.10	1.40
Steel bars, tidewater, New York	1.31	1.31	1.26	1.56
Tank plates, Pittsburgh	1.15	1.15	1.15	1.40
Tank plates, tidewater, New York	1.31	1.31	1.31	1.56
Beams, Pittsburgh	1.15	1.15	1.15	1.40
Beams, tidewater, New York	1.31	1.31	1.31	1.56
Angles, Pittsburgh	1.15	1.15	1.15	1.40
Angles, tidewater, New York	1.31	1.31	1.31	1.56
Skelp, grooved steel, Pittsburgh	1.15	1.15	1.12½	1.25
Skelp, sheared steel, Pittsburgh	1.20	1.20	1.20	1.30
SHEETS, NAILS AND WIRE, Per Pound to Largest Buyers:	Cents.	Cents.	Cents.	Cents.
Sheets, black, No. 28, Pittsburgh	1.90	1.90	1.85	2.20
Wire nails, Pittsburgh	1.55	1.55	1.50	1.70
Cut nails, Pittsburgh	1.50	1.50	1.45	1.60
Fence wire, annealed, 0 to 9, Pittsburgh	1.35	1.35	1.30	1.50
Barb wire, galv., Pittsburgh	1.85	1.85	1.80	2.00
METALS, Per Pound:	Cents.	Cents.	Cents.	Cents.
Lake copper, New York	14.25	14.25	13.37½	13.00
Electrolytic copper, New York	14.12½	14.12½	13.12½	12.75
Spelter, St. Louis	6.20	6.20	6.55	5.40
Spelter, New York	6.35	6.35	6.70	5.55
Lead, St. Louis	4.35	4.35	4.37½	4.35
Lead, New York	4.45	4.45	4.45	4.50
Tin, New York	44.25	45.25	45.50	39.55
Antimony, Hallett, New York	7.60	7.60	7.65	7.55
Tin plate, 100-lb. box, New York	$3.64	$3.64	$3.64	$3.84

*The average switching charge for delivery to foundries in the Chicago district is 50c. per ton.

Prices of Finished Iron and Steel f.o.b. Pittsburgh

Freight rates from Pittsburgh in carloads, per 100 lb., New York, 16c.; Philadelphia, 15c.; Boston, 18c.; Buffalo, 11c.; Cleveland, 10c.; Cincinnati, 15c.; Indianapolis, 17c.; Chicago, 18c.; St. Paul, 32c.; St. Louis, 22½c.; New Orleans, 30c.; Birmingham, Ala., 45c.; Pacific coast, 80c. on plates, structural shapes and sheets No. 11 and heavier; 85c. on sheets Nos. 12 to 16; 95c. on sheets No. 16 and lighter; 65c. on wrought pipe and boiler tubes.

Plates.—Tank plates, ¼ in. thick, 6¼ in. up to 100 in. wide, 1.15c., base, net cash, 30 days. Following are stipulations prescribed by manufacturers, with extras:

Rectangular plates, tank steel or conforming to manufacturers' standard specifications for structural steel dated February 6, 1903, or equivalent, ¼ in. thick and over on thinnest edge, 100 in. wide and under, down to but not including 6 in. wide, are base.

Plates up to 72 in. wide, inclusive, ordered 10.2 lb. per square foot, are considered ¼-in. plates. Plates over 72 in. wide must be ordered ¼ in. thick on edge, or not less than 11 lb. per square foot, to take base price. Plates over 72 in. wide ordered less than 11 lb. per square foot down to the weight of 3-16-in., take the price of 3-16-in.

Allowable overweight, whether plates are ordered to gauge or weight, to be governed by the standard specifications of the Association of American Steel Manufacturers.

Extras.	Cents per lb.
Gauges under ¼ in. to and including 3-16 in. on thinnest edge	.10
Gauges under 3-16 in. to and including No. 8	.15
Gauges under No. 8 to and including No. 9	.25
Gauges under No. 9 to and including No. 10	.30
Gauges under No. 10 to and including No. 12	.40
Sketches (including all straight taper plates) 3 ft. and over in length	.10
Complete circles, 3 ft. in diameter and over	.20
Boiler and flange steel	.10
"A. B. M. A." and ordinary firebox steel	.20
Still bottom steel	.30
Marine steel	.40
Locomotive firebox steel	.50
Widths over 100 in. up to 110 in., inclusive	.05
Widths over 110 in. up to 115 in., inclusive	.10
Widths over 115 in. up to 120 in., inclusive	.15
Widths over 120 in. up to 125 in., inclusive	.25
Widths over 125 in. up to 130 in., inclusive	.50
Widths over 130 in.	1.00
Cutting to lengths or diameters under 3 ft. to 2 ft., inclusive	.25
Cutting to lengths or diameters under 2 ft. to 1 ft., inclusive	.50
Cutting to lengths or diameters under 1 ft.	1.55

No charge for cutting rectangular plates to lengths 3 ft. and over.

Structural Material.—I-beams, 3 to 15 in.; channels, 3 to 15 in., and angles, 3 to 6 in. on one or both legs, ¼ in. and over, 1.15c. Other shapes and sizes are quoted as follows:

	Cents per lb.
I-beams over 15 in.	1.20 to 1.25
H-beams over 18 in.	1.30 to 1.35
Angles over 6 in.	1.20 to 1.25
Angles, 3 in. on one or both legs, less than ¼ in. thick, plus full extras, as per steel bar card Sept. 1, 1909	1.20 to 1.25
Tees, 3 in. and up	1.20 to 1.25
Zees, 3 in. and up	1.15 to 1.20
Angles, channels and tees, under 3 in., plus full extras as per steel bar card Sept. 1, 1909	1.20 to 1.25
Deck beams and bulb angles	1.45 to 1.50
Hand rail tees	2.00 to 2.15
Checkered and corrugated plates	2.00 to 2.15

Sheets.—Makers' prices for mill shipments on sheets of U. S. Standard gauge, in carload and larger lots, on which jobbers charge the usual advances for small lots from store, are as follows:

Blue Annealed Sheets.

	Cents per lb.
Nos. 3 to 8	1.30 to 1.35
Nos. 9 to 10	1.40 to 1.45
Nos. 11 and 12	1.45 to 1.50
Nos. 13 and 14	1.50 to 1.55
Nos. 15 and 16	1.60 to 1.65

Box Annealed Sheets, Cold Rolled.

	One Pass.	Three Pass.
Nos. 10 to 12	1.55 to 1.60	.....
Nos. 13 and 14	1.60 to 1.65	.....
Nos. 15 and 16	1.65 to 1.70	1.75 to 1.80
Nos. 17 to 21	1.70 to 1.75	1.80 to 1.85
Nos. 22, 23 and 24	1.75 to 1.80	1.85 to 1.90
Nos. 25 and 26	1.80 to 1.85	1.90 to 1.95
No. 27	1.85 to 1.90	1.95 to 2.00
No. 28	1.90 to 1.95	2.00 to 2.05
No. 29	1.95 to 2.00	2.05 to 2.10
No. 30	2.05 to 2.10	2.15 to 2.20

Galvanized Sheets of Black Sheet Gauge.

Nos. 10 and 11	1.90 to 1.95
Nos. 12, 13 and 14	2.00 to 2.05
Nos. 15, 16 and 17	2.15 to 2.20
Nos. 18 to 22	2.30 to 2.35
Nos. 23 and 24	2.40 to 2.45
Nos. 25 and 26	2.60 to 2.65
No. 27	2.75 to 2.80
No. 28	2.90 to 2.95
No. 29	3.00 to 3.05
No. 30	3.20 to 3.25

All above rates on sheets are f.o.b. Pittsburgh, terms 30 days net, or 2 per cent. cash discount in 10 days from date of invoice, as also are the following base prices per square for painted and galvanized roofing sheets, with 2½-in. corrugations:

Corrugated Roofing Sheets, Per Square.

Gauge.	Painted.	Galvanized.	Gauge.	Painted.	Galvanized.
29	.....	$2.30	23	$2.35	$3.45
28	$1.30	2.45	22	2.55	3.65
27	1.45	2.50	21	2.75	4.00
26	1.55	2.60	20	3.00	4.30
25	1.80	3.00	18	4.00	5.65
24	2.05	3.10	16	4.85	6.45

Wire Rods and Wire.—Bessemer, open hearth and chain rods, $24.50. Fence wire, Nos. 0 to 9, per 100 lb., terms 60 days, or 2 per cent. discount in 10 days, carload lots, to jobbers, annealed, $1.35; galvanized, $1.65. Carload lots, to retailers, annealed, $1.45; galvanized, $1.75. Galvanized barb wire to jobbers, $1.85; painted, $1.55. Wire nails, to jobbers, $1.55.

The following table gives the prices to retail merchants on wire in less than carloads, including the extras on Nos. 10 to 16, which are added to the base price:

Fence Wire, Per 100 Lb.

Nos.	0 to 9	10	11	12 & 12½	13	14	15	16
Annealed	$1.50	$1.55	$1.60	$1.65	$1.75	$1.85	$1.95	$2.05
Galvanized	1.80	1.85	1.90	1.95	2.05	2.15	2.55	2.65

Wrought Pipe.—The following are the jobbers' carload discounts on the Pittsburgh basing card on wrought pipe, in effect from December 1, 1911:

Butt Weld.

	Steel Black.	Steel Galv.	Iron Black.	Iron Galv.
⅜ and ¼ in.	74	54	68	48
⅜ in.	75	65	69	59
½ in.	78	68	72	62
¾ to 1¼ in.	81	73	75	67
2 to 3 in.	82	75	76	69

Lap Weld.

1¼ and 1½ in.	..	..	68	61
2 in.	79	72	72	65
2½ to 4 in.	81	74	74	67
4½ to 6 in.	80	72	73	65
7 to 12 in.	78	68	71	61
13 to 15 in.	55	..	47	..

Butt Weld, extra strong, plain ends, card weight.

⅛, ¼, ⅜ in.	70	60	65	55
⅜ in.	75	69	70	64
½ to 1¼ in.	79	73	74	68
2 to 3 in.	80	74	75	69

Lap Weld, extra strong, plain ends, card weight.

1¼ in.	..	..	66	60
2 in.	76	70	71	65
2½ to 4 in.	78	72	73	67
4½ to 6 in.	77	71	72	66
7 to 8 in.	70	60	65	55
9 to 12 in.	65	55	60	50

Butt Weld, double extra strong, plain ends, card weight.

½ in.	65	59	60	54
¾ to 1¼ in.	68	62	63	57
2 to 3 in.	70	64	65	59

Lap Weld, double extra strong, plain ends, card weight.

2 in.	66	60	61	55
2½ to 4 in.	68	62	63	57
4½ to 6 in.	67	61	62	56
7 to 8 in.	60	50	55	45

Plugged and Reamed.

1 to 1¼, 2 to 3 in. Butt Weld
2, 2½ to 4 in. Lap Weld

Will be sold at two (2) points lower basing (higher price) than merchants' or card weight pipe. Butt or lap weld as specified.

The above discounts are for "card weight," subject to the usual variation of 5 per cent. Prices for less than carloads are three (3) points lower basing (higher price) than the above discounts.

Boiler Tubes.—Discounts on lap welded steel and charcoal iron boiler tubes to jobbers in carloads are as follows:

Steel.

1¼ to 2¼ in.	63
2½ in.	67½
2¾ to 3¼ in.	72½
3½ to 4 in.	75
5 to 6 in.	67½
7 to 13 in.	65

Charcoal Iron.

1½ in.	48
1¾ to 2¼ in.	50
2½ in.	55
2¾ to 5 in.	60

2½ in. and smaller, over 18 ft., 10 per cent. net extra.
2¾ in. and larger, over 22 ft., 10 per cent. net extra.

Less than carloads will be sold at the delivered discounts for carloads, lowered by two points for lengths 22 ft. and under to destinations east of the Mississippi River; lengths over 22 ft. and all shipments going west of the Mississippi River must be sold f.o.b. mill at Pittsburgh basing discounts, lowered by two points.

The International Harvester Company announces that it will in the near future distribute $500,000 cash as a bonus to especially meritorious employees, being about the same as a year ago.

The B furnace of the Colorado Fuel & Iron Company at Pueblo, Col., was blown out December 11. Three furnaces were in blast January 1.

Pittsburgh

PITTSBURGH, PA., January 2, 1911. (*By Telegraph.*)

Pig Iron.—Some fair-sized inquiries are out. One is for 5000 tons of basic for second quarter and another for 1000 to 2000 tons, also of basic, for first half. The negotiations of the Pittsburgh Steel Company with the Pittsburgh Crucible Steel Company for the purchase of a large block of basic iron for shipment from Midland, Pa., have not yet been closed. We quote: Bessemer iron, $14.25; malleable Bessemer, $12.75; basic, $12.25 to $12.50; gray forge, $12.50 to $12.75; No. 2 foundry, $13 to $13.25, all at Valley furnace, the freight rate for delivery in Pittsburgh district being 90c. a ton.

Steel Billets and Sheet Bars.—Although new inquiry is dull, the steel companies have entered orders for a very heavy tonnage for delivery in first quarter and half. Actual orders sent to the mills for rolling by the billet and rail sales department of the Carnegie Steel Company in December, part for export, amounted to about 317,000 tons, an increase over November of 110,000 tons. We quote: Bessemer and open hearth billets, 4 x 4 in., up to 0.25 carbon, $20; Bessemer and open hearth sheet bars, $21, and forging billets, $27 to $28, Pittsburgh or Youngstown.

(By Mail.)

New orders and specifications in the last week of the year showed a seasonable falling off as compared with the previous three or four weeks. The Carnegie Steel Company has issued orders for the blowing in of five more blast furnaces—two at Edgar Thomson, two at Youngstown and Rosena at New Castle. The Jones & Laughlin Steel Company expects to start in a few days its four Talbot open-hearth furnaces at Aliquippa. Indications are that operations of blast furnaces, steel works and rolling mills will be much heavier in the first six months of the new year than in the last half of the year just closed. Prices are firm all along the line, and an early advance on wire products is expected.

Ferromanganese.—The price of $41, Baltimore, for standard English 80 per cent. is being firmly held. We note sales of 50 tons at this price for Pittsburgh delivery.

Ferrosilicon.—The Carnegie Steel Company has not yet covered on its inquiry for 6000 tons of 50 per cent. We quote 50 per cent. at $70, Pittsburgh, and the market is firm. Prices on the lower grades are weaker, being more or less shaded.

Muck Bar.—While inquiry is light, prices on high-grade muck bar are firm at $28 to $28.50, Pittsburgh.

Wire Rods.—Specifications against contracts are reported slightly better.

Steel Rails.—The three Edgar Thomson rail mills at Bessemer, Pa., start up today, after being shut down two weeks for repairs. The Carnegie Steel Company booked about 4000 tons of new orders and specifications for light rails in the past week. We quote splice bars at 1.50c. per lb., and repeat quotations on rails: Standard sections, 1.25c. per lb.; 8 and 10-lb. light rails, 1.25c.; 12 and 14-lb. 1.16c.; 16, 20 and 25-lb., 1.12c.; 30 and 35-lb., 1.10c., and 40 and 45-lb., 1.08c., f.o.b. at mill.

Structural Material.—The McClintic-Marshall Construction Company has taken a contract for 40,500 tons of steel for approaches to the Hell Gate bridge, New York; Cambria Steel Company, 800 tons for an addition to the works of the Edison Company, Detroit, and American Bridge Company, 1400 tons for bridge work for the Buffalo, Rochester & Pittsburgh railroad. Prices are firm and we quote beams and channels up to 15 in. at 1.15c. to 1.20c., at mill, Pittsburgh.

Plates.—The Bessemer & Lake Erie Railroad has given an order for 1000 all-steel hopper and gondola cars to the Pressed Steel Car Company and a similar order to the Standard Steel Car Company. The Elgin, Joliet & Eastern, owned by the Steel Corporation, is in the market for 1000 steel gondola and hopper cars. We quote ¼-in. and heavier plates at 1.15c. to 1.20c., at mill, Pittsburgh.

Sheets.—Specifications against contracts and new orders for sheets in December were the heaviest in any one month last year. The mills now have a large amount of work ahead. The American Sheet & Tin Plate Company has started up its Old Meadow sheet mill at Scottdale, Pa., having 8 hot mills, which had been shut down for a long time. The market is strong.

Tin Plate.—The mills start off the new year with a very heavy tonnage booked for delivery in first quarter and first half. The regular price of $3.40 per base box for 14 x 20 coke plates is reported as being better maintained than for some time.

Bars.—The steel-bar mills are heavily booked for first quarter and first half, but new orders and specifications in the past week have been quiet. We quote steel bars at 1.15c. to 1.20c. for first quarter and common iron bars 1.25c. to 1.30c., maker's mill.

Hoops and Bands.—The demand is better and specifications against contracts are heavier. We quote steel bands at 1.15c. to 1.20c., extras as per the steel bar card, and hoops at 1.25c. to 1.30c. for delivery through first half of 1912, f.o.b. car maker's mill, Pittsburgh.

Railroad Spikes.—Railroads have specified freely against contracts in the past two or three weeks, and the spike makers are well filled with orders for the first quarter. We quote $1.40 per 100 lb. in base sizes, f.o.b. Pittsburgh.

Rivets.—The new demand and specifications are reported better than for some weeks. Prices are firm at 1.40c. to 1.45c. for structural rivets and 1.50c. to 1.55c. for boiler rivets, in carload and larger lots, f.o.b. Pittsburgh.

Shafting.—Specifications against contracts from implement makers are being received in good volume, but new buying is light. We quote cold rolled shafting at 65 and 10 per cent. off in carload and larger lots delivered in base territory.

Spelter.—The new demand has been quiet in the past week, with prices stationary.

Wire Products.—New business and specifications have been better and an early advance of $1 a ton is looked for. We quote: Wire nails, $1.55; cut nails, $1.50; galvanized barb wire, $1.85; painted, $1.55; annealed fence wire, $1.35; galvanized fence wire, $1.65, f.o.b. Pittsburgh, usual terms, freight added to point of delivery.

Merchant Pipe.—The National Tube Company, through J. G. White & Co., New York City, has taken an order for 124 miles of 12-in. pipe for the Southern Gas Company of California for a line from Coalinga to Los Angeles, and has also received an order for 30 miles of 8-in. for the Texas company. A local mill has taken an order for 8 miles of 8-in. for a gas line for delivery to McAlester, Okla. The gas interests are now putting out heavy inquiries for June and July delivery. The pipe mills are taking orders at present prices for merchant pipe for delivery through the first quarter.

Tubes.—New orders for locomotive tubes have been heavy in the past two or three weeks as reports are that some very low prices are being made. Merchant tubes are dull, with very low prices ruling.

Iron and Steel Scrap.—The demand from consumers for heavy steel scrap, borings and turnings in the past week have been active, and prices are very firm. We note sales of about 3000 tons of cast iron borings at $9.60 to $9.75, delivered. The scrap lists of the railroads close earlier this month than usual, the Pennsylvania Railroad and Pennsylvania Lines West closing January 3 and 4 and the New York Central closing January 9. Prices on borings and turnings are higher. Dealers quote as follows, per gross ton, f.o.b. Pittsburgh, unless otherwise noted:

Heavy steel scrap, Steubenville, Follansbee, Sharon, Monessen and Pittsburgh delivery	$12.50 to $12.75
No. 1 foundry cast	11.75 to 12.00
No. 2 foundry cast	10.75 to 11.00
Bundled sheet scrap, f.o.b. consumers' mill, Pittsburgh district	10.25 to 10.50
Rerolling rails, Newark and Cambridge, Ohio, Cumberland, Md., and Franklin, Pa.	12.50 to 12.75
No. 1 railroad malleable stock	11.25 to 11.50
Grate bars	9.00 to 9.25
Low phosphorus melting stock	15.25 to 15.50
Iron car axles	20.50 to 21.00
Steel car axles	16.00 to 16.25
Locomotive axles	22.00 to 22.50
No. 1 busheling scrap	11.00 to 11.25
No. 2 busheling scrap	7.00 to 7.25
Old car wheels	12.00 to 12.25
*Cast iron borings	9.00 to 9.25
*Machine shop turnings	9.25 to 9.50
†Sheet bar crop ends	13.75 to 14.00
Old iron rails	14.50 to 14.75
No. 1 wrought scrap	12.00 to 12.25
Heavy steel axle turnings	9.75 to 10.00
Stove plate	9.00 to 9.25

*These prices are f.o.b. cars at consumers' mills in the Pittsburgh district.
†Shipping point.

Coke.—There is still a scarcity of blast furnace coke for prompt shipment and as high as $1.85 to $1.90 per net ton has been paid for prompt delivery. Lower prices will probably rule as soon as normal operations are resumed in the coke regions. Prices on foundry coke are also higher, and it is held at $2 to $2.10 per net ton at oven for spot shipment.

Chicago

CHICAGO, January 2, 1912. (*By Telegraph.*)

The market situation at the beginning of the year, both as regards the tonnage of orders booked and the gradually returning strength of prices, is considered sound. The necessity for catering to desirable customers has not yet entirely disappeared, and the Chicago market continues independent of any other basing points in its quotations. The local pig iron situation has been strengthened by the advancing of prices for Chicago-made iron to $14.50 at furnace by one interest. The advance in the prices of old material seems to have carried values above the market that present consumption will support, and it is anticipated that a further rise will be checked.

(By Mail.)

Pig Iron.—The interest in Northern iron has not fallen off as much as in Southern. A number of sales are reported, and with one local interest again asking $14.50 f.o.b. furnace as its minimum, the Northern market, with the exception of the Milwaukee district, shows a real increase in strength. At Milwaukee local competition seems to have brought out prices surprisingly low in view of the Chicago price. We continue to quote for Chicago delivery, except for local irons, which are f.o.b. furnace, the following prices on prompt shipments:

Lake Superior charcoal	$16.00 to $16.50
Northern coke foundry, No. 1	14.50 to 15.00
Northern coke foundry, No. 2	14.00 to 14.50
Northern coke foundry, No. 3	13.50 to 14.00
Northern Scotch, No. 1	16.00
Southern coke, No. 1 foundry and No. 1 soft	14.85
Southern coke, No. 2 foundry and No. 2 soft	14.35
Southern coke, No. 3	14.10 to 14.35
Southern coke, No. 4	13.85 to 14.10
Southern gray forge	13.60 to 13.85
Southern mottled	13.60 to 13.85
Malleable Bessemer	14.35 to 14.50
Standard Bessemer	16.75
Basic	14.75
Jackson County and Kentucky silvery, 6 per cent.	16.40
Jackson County and Kentucky silvery, 8 per cent.	17.40
Jackson County and Kentucky silvery, 10 per cent.	18.40

Rails and Track Supplies.—We quote standard railroad spikes at 1.50c., base; track bolts, with square nuts, 1.90c., base, all in carload lots, Chicago; standard section Bessemer rails, 1.28c.; open hearth, 1.34c.; light rails, 40 to 45 lb., 1.16c. to 1.20c.; 30 to 35 lb., 1.19½c. to 1.24c.; 16, 20 and 25 lb., 1.20½c. to 1.25c.; 12 lb., 1.25c. to 1.30½c; angle bars, 1.50c., Chicago.

Structural Material.—Specifications have been more active than new orders. Architectural work is quiet, and 138 tons for a local fire engine house, awarded to the George E. Laubenheimer Company, is the only contract reported. We quote for Chicago delivery, mill shipment, 1.33c. to 1.38c., and from store 1.60c.

Plates.—The market continues to evince decided firmness and business is being received steadily. We quote for Chicago delivery, mill shipment, 1.33c. to 1.38c., and from store 1.60c.

Sheets.—The holiday week has produced little beyond an affirmation of the improved situation as regards sheets. We quote Chicago prices as follows: Carload lots, from mill, No. 28 black sheets, to 2.08c.; No. 28 galvanized, to 3.08c.; No. 10 blue annealed, to 1.58c. Prices from store, Chicago, are: No. 10, 1.90c.; No. 12, 1.95c.; No. 28 black, 2.30c.; No. 28 galvanized, 3.35c.

Bars.—Bar mills feel that their position is well established for a sufficient period in advance to warrant the firmest attitude as regards price. Few quotations on steel bars are now below 1.30c., Chicago, and with some producers 1.33c. is the absolute minimum. We quote as follows, f.o.b. Chicago: Soft steel bars, 1.25c. to 1.33c.; bar iron, 1.15c. to 1.20c.; hard steel bars rolled from old rails, 1.15c. to 1.20c. From store: Soft steel bars, 1.50c. to 1.55c., Chicago.

Wire Products.—December proved to be a notably better month than November, in contrast to the traditional slackening that comes with the close of the year. Wire nails especially were active, and spring trade supported the buying of barb and fence wire. We quote: Plain wire, No. 9 and coarser, base, $1.53; wire nails, $1.73; painted barb wire, $1.73 to $1.78; galvanized, $2.03 to $2.08; polished staples, $1.78 to $1.83; galvanized, $2.08 to $2.13, all Chicago.

Old Materials.—The market prices at which scrap is being held show advances of nearly $2 a ton in the past 30 days. Prices paid to the railroads last week apparently touched the high point. The market is now somewhat topheavy, and dealers are offering scrap freely with little buying interest displayed at the present quotations. In keeping with the advances since our last report we revise our prices and quote for delivery at buyers' works, Chicago and vicinity, all freight and transfer charges paid, per gross ton, as follows:

Old iron rails	$14.75 to $15.25
Old steel rails, rerolling	12.75 to 13.25
Old steel rails, less than 3 ft.	11.75 to 12.25
Relaying rails, standard section, subject to inspection	24.00
Old car wheels	13.25 to 13.75
Heavy melting steel scrap	10.50 to 11.00
Frogs, switches and guards, cut apart	10.50 to 11.00
Shoveling steel	10.25 to 11.00
Steel axle turnings	8.50 to 9.00

The following quotations are per net ton:

Iron angles and splice bars	$12.75 to $13.25
Iron arch bars and transoms	13.75 to 14.25
Steel angle bars	10.00 to 10.50
Iron car axles	18.00 to 18.50
Steel car axles	15.50 to 16.00
No. 1 railroad wrought	11.50 to 12.00
No. 2 railroad wrought	10.50 to 11.00
Steel knuckles and couplers	10.00 to 10.50
Steel springs	10.50 to 11.00
Locomotive tires, smooth	13.25 to 13.75
Machine shop turnings	6.75 to 7.25
Cast and mixed borings	6.00 to 6.50
No. 1 busheling	9.00 to 9.50
No. 2 busheling	6.25 to 6.75
No. 1 boilers, cut to sheets and rings	7.00 to 7.50
Boiler punchings	12.50 to 13.00
No. 1 cast scrap	11.00 to 11.50
Stove plate and light cast scrap	9.25 to 9.75
Railroad malleable	10.75 to 11.25
Agricultural malleable	9.00 to 9.50
Pipes and flues	8.00 to 8.50

Philadelphia

PHILADELPHIA, PA., January 2, 1912.

Quite a fair amount of business has been moving in foundry pig iron, with some little inquiry for steel-making grades. A better movement in billets and sheets is reported.

Iron Ore.—Reports of sales of domestic grades for 1912 shipment are heard.

Pig Iron.—A Delaware River pipe maker has closed for 5000 tons of forge and No. 3 foundry for March shipment, 3000 tons going to Northern and 2000 tons to Southern makers, at about $14, delivered. A sale of 700 tons of Southern forge, at $9, Birmingham, was also made to a Virginia pipe maker. Pennsylvania No. 2 X foundry is firm. While more producers are gradually filling up order books and withdrawing the recent minimum quotation, $14.85 to $14.90, delivered, can still be done, although some hold firmly at $15 and $15.25. Virginia foundry has been selling freely in lots of a few hundred tons at $12.25 to $12.50, furnace, a large amount of the business going to stove and other foundries at the top of the market. A sale of 700 tons of Virginia foundry was made to the Baltimore & Ohio Railroad at $12.50, furnace, over half of which was for prompt shipment. Small lots of Southern iron are moving at $10.25, Birmingham, for first quarter shipment. Sales of Southern forge iron have also been made to rolling mills in this district at $9, Birmingham. While the general movement in steel-making iron has been light, one consumer is in the market for 3000 tons of Bessemer, 2000 tons of basic and 3000 tons of low phosphorus, for delivery over the first four months. Quotations are firm, the following range being quoted for deliveries in buyers' yards during the first quarter and half:

Eastern Pennsylvania No. 2 X foundry	$14.85 to $15.25
Eastern Pennsylvania No. 2 plain	14.60 to 15.00
Virginia foundry	15.00 to 15.50
Gray forge	14.25
Basic	14.25 to 14.50
Standard low phosphorus	19.25 to 19.50

Ferroalloys.—Little inquiry has developed, and the price of 80 per cent. ferromanganese remains at $41, Baltimore. Negotiations are pending for 50 per cent. ferrosilicon, which continues to be quoted at $70, delivered.

Billets.—The market is more active and decidedly firmer, with $22.40, delivered, generally quoted for basic open-hearth rolling billets. Forging billets are in good demand at $26.40 to $27.40, delivered.

Plates.—Some contracts for first quarter delivery have been closed and specifications have been a trifle heavier. Several mills now quote 1.35c. to 1.40c., delivered, as a minimum, although on competitive business 1.30c. is still reported available.

Structural Material.—Few of the pending contracts have been closed and little new business has come out. Prices are firm at 1.30c. to 1.35c., delivered, for plain shapes.

Sheets.—Mills report a material increase in the volume of business offered, both for early as well as forward delivery. Price concessions are no longer avail-

able, 2.05c., delivered, representing the minimum quotation for Western No. 28 gauge, on which Eastern mills making smooth, loose sheets obtain ¼c. to ½c. per lb. advance.

Coke.—Continued activity is reported in furnace coke. Up to $1.80 at oven has been obtained for prompt coke, which is scarce. While $1.75 to $1.85 at oven is now quoted for forward furnace coke, business under negotiation for several weeks, aggregating probably 80,000 to 100,000 tons, has been put through on old options at $1.65 to $1.70 at oven. Some little business in foundry coke has been put through at $2.15 to $2.25 at oven. The following range of prices, per net ton, is named for deliveries in buyers' yards in this vicinity:

Connellsville furnace coke	$3.85 to $4.00
Foundry coke	4.15 to 4.50
Mountain furnace coke	3.60 to 3.75
Foundry coke	3.95 to 4.40

Old Material.—The market is inactive, but prices are fully maintained. Small lots of No. 1 heavy melting steel have been taken at $12.25, delivered, but $12.50 is paid for strictly No. 1 railroad steel. Rolling mills are expected to come into the market more freely in the very near future. The following range of prices about represents quotations at which the ordinary current business for prompt shipment can be done for delivery in buyers' yards, eastern Pennsylvania and nearby points, taking a freight rate from Philadelphia varying from 35c. to $1.35 per gross ton, for shipment ranging from prompt to the remainder of the year:

No. 1 heavy melting steel scrap	$12.25 to $12.75
Old steel rails, rerolling (nominal)	14.00 to 14.50
Low phosphorus heavy melting steel scrap	15.50 to 16.00
Old steel axles	17.50 to 18.00
Old iron axles	22.00 to 23.00
Old iron rails	16.00 to 17.00
Old car wheels	12.50 to 13.00
No. 1 railroad wrought	15.50 to 16.00
Wrought iron pipe	11.75 to 12.25
No. 1 forge fire	10.25 to 10.75
No. 2 light iron (nominal)	6.75 to 7.25
Wrought turnings	9.00 to 9.50
Cast borings	8.25 to 8.75
Machinery cast	13.25 to 13.75
Railroad malleable (nominal)	11.75 to 12.25
Grate bars, railroad (nominal)	10.00 to 10.50
Stove plate	10.25 to 10.75

J. Tatnall Lea & Co., iron and steel, coal, coke and iron ores, Stephen Girard Building, Philadelphia, announce the withdrawal from the firm of Robert C. Lea and of the admission as partners of Cyrus D. Tatman and Charles Carter Renshaw.

Robert C. Lea, 426 Stephen Girard Building, Philadelphia, announces that he will conduct a business for the sale of pig iron, iron ore, coal and coke, and as sole agent for the sale of Robesonia low phosphorus pig iron, trading under the name of Robert C. Lea & Co.

Cincinnati

CINCINNATI, OHIO, January 2, 1912.—(*By Telegraph.*)

Pig Iron.—Buying in December was reported to have been much heavier than for several months, Southern furnaces getting their full share of the orders placed. A large number of consumers have not yet filled for first half requirements, and as soon as the effects of the holiday season wear off another spurt of activity is expected. While considerable Southern No. 2 foundry for first half movement is available at $10, Birmingham, several producers are holding out for $10.50. Northern No. 2 foundry and malleable are quoted around $13, Ironton, for any shipment until July 1. A central Ohio manufacturer is expected to close to-day for 4000 tons of malleable. Among holiday season sales is one of 500 tons of Southern No. 2 foundry to a southern Ohio melter at $10 at furnace for first half shipment. Off grades of both Northern and Southern iron continue in fair demand. Based on freight rates of $3.25 from Birmingham and $1.20 from Ironton, we quote f.o.b. Cincinnati as follows for prompt shipment:

Southern coke, No. 1 foundry and 1 soft	$13.75 to $14.25
Southern coke, No. 2 foundry and 2 soft	13.25 to 13.75
Southern coke, No. 3 foundry	12.75 to 13.25
Southern coke, No. 4 foundry	12.50 to 13.00
Southern gray forge	12.50 to 13.00
Ohio silvery, 8 per cent. silicon	16.45 to 16.95
Lake Superior coke, No. 1	14.70 to 14.95
Lake Superior coke, No. 2	14.20 to 14.45
Lake Superior coke, No. 3	13.70 to 13.95
Basic, Northern	14.20 to 14.45
Standard Southern car wheel	25.25 to 25.50
Lake Superior car wheel	19.00

(By Mail.)

Finished Material.—Not much business in this territory was transacted during the holiday season, although the total was much better than last year's. Prices are very firm, and while no change has been reported in retail quotations it is thought that they will be advanced some time soon. Steel bars are quoted at 1.55c. to 1.60c., and structural material 1.65c. to 1.70c. The minimum mill price on steel bars, for delivery up until April 1, is said to be 1.15c., Pittsburgh.

Old Material.—The market is very dull, and no change is anticipated until well along in the month. Prices remain firm despite the limited demand. The minimum figures given below about represent what buyers are willing to pay for delivery at their yards in southern Ohio and Cincinnati, and the maximum quotations the selling prices f.o.b. at yards:

No. 1 railroad wrought, net ton	$9.75 to $10.50
Cast borings, net ton	4.50 to 5.00
Steel turnings, net ton	5.50 to 6.00
No. 1 cast scrap, net ton	9.50 to 10.25
Burnt scrap, net ton	6.50 to 7.00
Old iron axles, net ton	16.25 to 16.75
Bundled sheet scrap, gross ton	6.25 to 6.75
Old iron rails, gross ton	13.00 to 13.75
Relaying rails, 50 lb. and up, gross ton	20.75 to 21.50
Old car wheels, gross ton	10.50 to 11.00
Heavy melting steel scrap, gross ton	9.50 to 10.00

Cleveland

CLEVELAND, OHIO, January 2, 1912.—(*By Telegraph.*)

Pig Iron.—The market was quite active the past week, orders being largely for foundry grades. One 2000 and several 1000-ton lots were sold. We also note the sale of 5000 tons of malleable iron for delivery over four months, and the buyer may decide to take 5000 tons more to cover the first half. Inquiry for foundry grades is still good, the largest being for 4000 tons. While some sellers are holding for better prices, others have not withdrawn recent quotations. Southern iron is firmer; some sales of No. 2 have been made at $10.50, Birmingham. We quote as follows for prompt shipment and for the first half, delivered Cleveland:

Bessemer	$15.15
Basic	13.25
Northern foundry No. 2	$13.25 to 13.50
Southern foundry No. 2	14.35 to 14.85
Gray forge	12.50
Jackson County silvery, 8 per cent, silicon	17.05

(By Mail.)

Iron Ore.—Consumers generally have good-sized stocks, and it is not believed that they will show any anxiety to buy their year's requirements until well along in the spring. Sellers also are disposed to favor a late buying movement. We quote prices as follows: Old range Bessemer, $4.50; Mesaba Bessemer, $4.25; old range non-Bessemer, $3.70; Mesaba non-Bessemer, $3.50.

Coke.—One or two local foundries have closed contracts for foundry grades in the past few days, but the market as a whole is quiet. Standard Connellsville furnace coke is held at $1.65 to $1.75 for delivery through the first half. We quote standard Connellsville foundry coke at $2 to $2.15 per net ton at oven for spot shipment, and $2.15 to $2.40 for contract.

Finished Iron and Steel.—Specifications have been very satisfactory. Orders on contract for steel bars were quite plentiful; prices on bars are well maintained at 1.15c., Pittsburgh, for delivery until April 1. While the general quotation on plates and structural material is 1.20c., Pittsburgh, the plate market is not so firm as structural material and steel bars. Some quotations of 1.10c. for steel bars, and similarly low prices on plates and shapes that were cut a few weeks ago, were not withdrawn, consumers being given until January 1, and a number of such contracts have been closed during the week. For second quarter delivery mills generally are quoting $1 a ton over present prices, but do not appear anxious to take much at this advance. Bids were received December 27 for 7000 tons for the Michigan Central depot in Detroit, but the placing of the contract was deferred until after bids are opened this week for 3000 tons additional for train sheds. The order for 4000 tons of Bessemer rails for the Nickel Plate Railroad has finally been placed with the Illinois Steel Company, the contract also being placed for the necessary splices and track bolts. The demand for iron bars is light, and we quote 1.20c., Cleveland mill.

Old Material.—Some small lots of scrap that dealers were anxious to dispose of were sold during the week at rather low prices, but the market generally is firm. Dealers have advanced the price of heavy steel

scrap about 50c. a ton, and are asking higher prices for some other grades. Several large offerings of railroad scrap will be disposed of early in the month. Dealers' prices, per gross ton, f.o.b. Cleveland, are as follows:

Old steel rails, rerolling	$12.25 to $12.75
Old iron rails	14.00 to 14.50
Steel car axles	17.50 to 18.00
Heavy melting steel	11.50 to 12.00
Old car wheels	12.25 to 12.50
Relaying rails, 50 lb. and over	22.50 to 23.50
Agricultural malleable	10.50 to 11.00
Railroad malleable	11.75 to 12.00
Light bundled sheet scrap	9.50 to 10.00

The following prices are per net ton, f.o.b. Cleveland:

Iron car axles	$18.50 to $19.00
Cast borings	6.25 to 6.50
Iron and steel turnings and drillings	6.75 to 7.00
Steel axle turnings	7.25 to 7.75
No. 1 busheling	9.50 to 10.00
No. 1 railroad wrought	11.00 to 11.25
No. 1 cast	11.25 to 11.75
Stove plate	9.00 to 9.25
Bundled tin scrap	11.00 to 11.50

Birmingham

BIRMINGHAM, ALA., January 1, 1912.

Pig Iron.—Only carloads and lots of 150 to 300 tons figured in the week's transactions, mainly for early delivery. The basis of $10, Birmingham, for No. 2 foundry is still considered effective for deliveries to cover the entire first half. Pipe manufacturers are inquiring for prices on 7500 to 10,000 tons of Nos. 2, 3 and 4 for first half, and a large pump manufacturing interest is in the market for 1000 to 1200 tons of low silicon iron for first quarter. A leading producing interest has just announced an advance of 25c. per ton in the asking price for all deliveries, making its rate $10.50, Birmingham. This price is being adhered to firmly by another, and those concerns who were reported some weeks ago as having practically withdrawn from the market are not accredited with having made solicitations since that time. In view of such conditions it is reasonably certain that the tonnage now available at the $10 price is in the hands of probably two large producers. It is probable that one furnace now in blast will be blown out during the coming month for relining, and no announcement has been made of the intention to substitute any other stack. Stock figures as of January 1 will hardly be available before January 6. The aggregate accumulation has probably increased. Shipping instructions that have just been issued for the first weeks in January represent a very satisfactory tonnage, and indicate that a resumption of foundry operations, especially in the South, has been general. The market is quoted as below for the entire first half, which prices are per gross ton f.o.b. cars at Birmingham district furnaces:

No. 1 foundry and No. 1 soft	$10.50
No. 2 foundry and No. 2 soft	10.00
No. 3 foundry	9.50
No. 4 foundry	9.25
Gray forge	9.00
Standard basic	10.00
Off basic	9.50

Cast Iron Pipe.—Local producers have just submitted bids on approximately 1500 tons of water pipe for requirement at Muskogee, Okla., and also on 3000 tons for Minneapolis, Minn. Several small orders are under consideration. We continue to quote water pipe as follows, per net ton, f.o.b. cars here; 4 to 6-in., $23; 8 to 12-in., $22; over 12-in., average, $21, with $1 per ton extra for gas pipe. Special fittings are quotable at $45 to $50 per net ton at foundry.

Old Material.—Trading has been light, but the market is considered in a more satisfactory condition than for some months. We continue to quote asking prices as follows, per gross ton, f.o.b. cars here:

Old iron axles (light)	$12.00 to $12.50
Old steel axles (light)	11.00 to 11.50
Old iron rails	11.00 to 11.50
No. 1 railroad wrought	10.00 to 10.50
No. 2 railroad wrought	8.50 to 9.00
No. 1 country wrought	6.00 to 6.50
No. 2 country wrought	5.50 to 6.00
No. 1 machinery	8.50 to 9.00
No. 1 steel	8.00 to 8.50
Tram car wheels	7.50 to 8.00
Standard car wheels	9.50 to 10.00
Light cast and stove plate	6.00 to 6.50

It is understood that the Woodward Iron Company will not take formal charge of the properties of the Birmingham Coal & Iron Company until February 1, owing to the delay in arranging certain details necessary for the transfer.

Boston

BOSTON, MASS., January 2, 1912.

Old Material.—The scrap market continues fairly active, with no change in quotations. The prices quoted below are those offered by the large dealers to the producers and to the smaller dealers and collectors, per gross ton, carload lots, f.o.b. Boston and other New England points, taking Boston rates from eastern Pennsylvania points. In comparison with Philadelphia prices the differential for freight of $2.30 a ton is included. Mill prices are approximately 50c. a ton more than dealers' prices.

Heavy melting steel	$9.50 to $10.00
Low phosphorus steel	11.45 to 11.95
Old steel axles	14.00 to 14.50
Old iron axles	17.00 to 18.00
Mixed shafting	12.75 to 13.25
No. 1 wrought and soft steel	11.00 to 11.25
Wrought iron pipe	9.25 to 9.50
Skeleton (bundled)	7.00 to 7.50
Cotton ties	7.00 to 7.50
No. 2 light	4.50 to 5.00
Wrought turnings	5.00 to 5.50
Cast borings	4.50 to 5.00
Machinery, cast	12.50 to 13.00
Malleable	9.25 to 9.75
Grate bars	6.00 to 6.50
Stove plate	8.00 to 8.50

San Francisco

SAN FRANCISCO, CAL., December 26, 1911.

Owing to the prevalent holiday feeling, the jobbing movement in the local market is about at a minimum, and no general resumption of activity is expected for the next week or two. The general outlook for the first quarter, however, is considered good. Most merchants and a few of the largest consumers have placed contracts covering their anticipated requirements of the first quarter, and in some cases the first six months of 1912. The stiffening of prices in the primary markets has given great encouragement to the coast trade, and a material improvement is also expected in the consuming demand of this territory.

Bars.—Aside from the placing of contracts by dealers, little business is reported. A good local movement of reinforcing material is expected during January. Local jobbing prices are unchanged, standing at 2c. for steel and 1.90c. for iron.

Structural Material.—The outlook is rather encouraging for the coast as a whole. While large buildings are not now regarded with much favor in San Francisco, plans are being drawn for many structures of moderate size, requiring in the aggregate a heavy tonnage of steel, and considerable municipal and Government work is in sight.

Rails.—No definite inquiries of any importance are coming up at present. The logging interests should begin to enter the market about the end of January, and are expected to buy freely during the spring. Many new orders from interurban and street railroads are also expected about the end of the first quarter.

Sheets.—The recent advance has brought out considerable business, both from merchants and large manufacturers, though most of the orders are for extended delivery. Some large orders have recently been placed with manufacturers of riveted pipe, both here and in southern California, and the requirements of this industry during the coming year are expected to be unusually large, owing mainly to the increasing area of irrigated land. Local resale prices on both galvanized and blue annealed sheets continue extremely low, and little business is being taken by merchants, though the outlook for January is fairly good.

Plates.—The distributive movement is light, though practically all jobbers have placed contracts for delivery through the first quarter. Notwithstanding the Eastern advance, local merchants have cut prices. This is ascribed to purely local competitive conditions, and has no particular significance.

Merchant Pipe.—Supplies are light and merchants anticipate a greatly improved demand in the spring. A large inquiry for line pipe is reported in southern California. The Standard Oil Company is said to be preparing to lay another line from its Kern River storage station to the Richmond refinery. General business in the oil fields continues quiet. The order for the Exeter, Cal., water system went to the Crane Company.

Cast Iron Pipe.—Little new business has come out, though a good movement is expected before the end of January. The Hollywood Union Water Company has ordered 3 miles of 4-in. pipe for delivery at Los Angeles, and the Pacific Gas & Electric Company has ordered a lot of 30 and 36-in. pipe for the Stockton,

Cal., water system. Las Cruces, N. M., has decided on cast iron pipe for its water system, and the general contract has been let. McMinnville, Ore., is in the market for a considerable tonnage.

Pig Iron.—Some contracts are said to have been placed for future delivery, but both buyers and sellers show hesitation, owing to the uncertainty of the Chinese situation. No. 2 Southern foundry iron is nominally quoted at $20; ordinary brands of English and Continental at $20 to $22, and Chinese at $23.

Old Material.—All lines are extremely dull and prices are largely nominal. Negotiations are under way on several large transactions, and dealers anticipate a heavy movement after the turn of the year. Large inquiries have been received, both from foreign interests and coast steel plants. Prices are nominally as follows: Cast iron scrap, per net ton, $14; steel melting scrap, per gross ton, $11.50; wrought scrap, per net ton, $12.50 to $15; rerolling rails, per net ton, $11.

Metals.—The city of Portland, Ore., will receive bids January 9 for 100 tons of pig lead.

New York

NEW YORK, January 2, 1912.

Pig Iron.—Foundry buying has been meager in this district, somewhat in contrast with conditions in eastern Pennsylvania markets. New England buyers appear to be generally covered for the first quarter, and in New York State the heavy November and December buying from Buffalo furnaces has left the foundries in much the same position, a good many having their supply under contract for the first half. While one small Lehigh Valley furnace has gone out, three Pennsylvania furnaces which sell in the Eastern market have gone in in the past month. Some pipe iron has been sold, one foundry taking 5000 tons in the past week. The scale of operations at machinery foundries is practically unchanged. Quotations are as follows for Northern iron at tidewater: No. 1 foundry, $15 to $15.25; No. 2 X, $14.75; No. 2 plain, $14.50 to $14.75. For Southern iron we quote $15 to $15.25 for No. 1 foundry and $14.50 to $14.75 for No. 2 foundry.

Finished Iron and Steel.—The run of business in general lines continues on the level of the last few weeks, discounting the immediate effect of the holiday season. The one exception is perhaps the structural line, where the expectation that some large work would be settled before the end of the year was fulfilled. As these projects are closed, one after the other, prices of fabricated material will, it is thought, stiffen to an extent commensurate with the higher prices generally obtaining for plain structural shapes. One encouraging sign is the appearance of more inquiries for loft buildings in New York City. As regards prices, such as steel bars for second quarter, one large interest at least has not settled on a definite policy, indicating an intention to ask for 1.20c., Pittsburgh, if it is at all possible, for deliveries up to July 1. The largest contract award of the week was the viaduct and bridge approaches to the New York Connecting Railroad bridge, the large arch span for which and the immediate approach spans for which were given to the American Bridge Company some time ago. The present award was made to the McClintic-Marshall Construction Company, and amounts to nearly 41,000 tons. Among the large building work which has been settled are the following: Auerbach candy factory, 4500 to 5000 tons, to the Hav Foundry & Iron Works, which also took a loft building on Twenty-third street, 600 tons, and also the Baron de Hirsch school, 500 tons; the Graphic Arts publishing building, 2000 tons, to Post & McCord; the Building & Engineering Company's building on West Twenty-fifth street, 900 tons, to Hinkle Iron Company; Cooper Union building, 800 tons, to Milliken Brothers; building for the Armstrong Cork Company, Lancaster, Pa., 400 tons, to the American Bridge Company, which also received a 300-ton award for the Federal Sugar Refining Company at Yonkers, N. Y.; a 12-story building, 125 West Twenty-sixth street, 700 tons, to A. E. Norton Company; American Sugar Refining Company's building, Boston, 400 tons, to the Boston Bridge Works. The Bing & Bing loft building, on Twentieth street and Broadway, some 4000 tons, is practically closed at this writing. Among the new projects may be mentioned the Bing & Bing apartment, about Seventy-ninth street, 1500 tons; two loft buildings totaling 1600 tons; the Mount Royal Hotel, Montreal, 2300 tons, and a building which it is thought will shortly be erected for the Coca-Cola Company, 220-226 West Forty-second street, extending to Forty-first street. Quotations are: Steel bars, plates and plain structural material, 1.31c. to 1.36c.; bar iron, 127½c. to 1.32½c., all New York. Plain material from store, New York, 1.60c. to 1.70c.

Cast-Iron Pipe.—The only public letting of importance this week is scheduled for January 3, when the city of Baltimore opens its requirements for the year, comprising about 1800 tons of 4-in. to 48-in. water pipe. The general situation is very much better than that of a year ago at this time, as foundries are well supplied with work. Carload lots of 6-in. are quoted at $22 to $23 per net ton, tidewater.

Old Material.—While transactions have been light, dealers maintain a firm attitude in the belief that a much better demand is impending which should be attended with somewhat higher prices. Dealers' prices per gross ton, New York and vicinity, are as follows:

Old girder and T rails for melting	$10.25 to $10.50
Heavy melting steel scrap	10.25 to 10.50
Relaying rails	20.50 to 21.00
Rerolling rails (nominal)	12.00 to 12.50
Standard hammered iron car axles	20.00 to 20.50
Old steel car axles	15.50 to 16.00
No. 1 railroad wrought	12.50 to 13.00
Wrought iron track scrap	12.00 to 12.50
No. 1 yard wrought, long	11.00 to 11.50
No. 1 yard wrought, short	10.25 to 10.50
Light iron	4.75 to 5.00
Cast borings, clean	6.50 to 6.75
Mixed borings and turnings	5.50 to 5.75
Wrought turnings	6.75 to 7.00
Wrought pipe	9.75 to 10.00
Old car wheels	12.00 to 12.50
No. 1 heavy cast, broken up	11.00 to 11.50
Stove plate	8.75 to 9.00
Locomotive grate bars	9.00 to 9.50
Malleable cast	10.00 to 10.50

Ferroalloys.—The price of 80 per cent. ferromanganese is unchanged at $41 and 50 per cent. ferrosilicon is quoted at $70, with 200 tons sold at $69, while a carload brought $70.

Metal Market

NEW YORK, January 2, 1912.

The Week's Prices

Cents Per Pound for Early Delivery.

	Copper, New York.			Lead		Spelter	
1911 Dec.	Lake.	Electrolytic.	Tin, New York.	New York.	St. Louis.	New York.	St. Louis.
28	14.25	14.12½	45.00	4.45	4.35	6.35	6.20
29	14.25	14.12½	44.80	4.45	4.35	6.35	6.20
30	14.25	14.12½	44.90	4.45	4.35	6.35	6.20
1912 Jan. 2	14.25	14.12½	44.25	4.45	4.35	6.35	6.20

Copper is strong, with a moderate domestic demand. Tin is irregular with freer offerings. Lead is unchanged. Spelter shows no activity.

New York

Copper.—The copper market has been extremely quiet during the last week. Practically the only feature worthy of note, aside from the sustained prices, is the exports for December, which reached the large figure of 37,430 tons. In the latter half of last week there was a tendency on the part of second hands to shade prices a trifle, which, however, met with but a light response from consumers. Spot copper in London is quoted to-day at £63 8s. 9d. and futures at £64 5s.

Pig Tin.—Very little has been done in tin, although there are a few inquiries from those who want early delivery. Cables from London this morning brought the news that tin was off about £2 and later in the day came information that it had declined £2 more. Owing to the inactivity prevailing here the London drop in price caused no flurry. Spot tin was quoted in London today at £201 and futures at £188 10s. In New York today the price is 44.25c., a decline of about ¾c. from December 28. Both in the latter part of last week and today there have been somewhat freer offerings as a result of the heavier stocks in this country. The arrivals of tin at the Atlantic ports in the month of December amounted to 4296 tons and there is afloat 1735 tons. Figures compiled by C. Mayer, secretary of the New York Metal Exchange, make shipments from the Straits for December 1460 tons larger than for the same month of 1910. The total visible supply December 31, 1911, was 16,514 tons, 680 tons below that of December 31, 1910.

Tin Plates.—There will be little activity until demands are renewed from the can makers and tinware manufacturers. The price of tin plates laid down at Swansea, Wales, is unchanged at 13s. 7½d. The price

in New York for 100 lb. coke plates is unchanged at $3.64.

Lead.—The lead market is without feature. Prices are unchanged at 4.45c., New York, and 4.35c., St. Louis

Spelter.—Practically no activity has been apparent during the week. Prices are unchanged at 6.35c., New York, and about 6.20c., St. Louis.

Antimony.—As with the other metals, there has been little or no movement in antimony. Cookson's is quoted at 7.75c. to 7.87½c.; Hallett's, 7.60c. to 7.70c., and Hungarian and Chinese grades at 7c. to 7.12½c.

Old Metals.—Prices are firm, with a good demand. Dealers' selling prices are as follows:

	Cents per lb.
Copper, heavy and crucible	13.50 to 14.00
Copper, heavy and wire	13.25 to 13.50
Copper, light and bottoms	12.00 to 12.25
Brass, heavy	9.25 to 9.50
Brass, light	7.25 to 7.50
Heavy machine composition	11.25 to 11.50
Clean brass turnings	8.75 to 9.00
Composition turnings	9.50 to 10.00
Lead, heavy	4.25
Lead, tea	4.00
Zinc, scrap	5.25

Chicago

JANUARY 2.— The metal market has been quiet through the holiday season. Copper quotations show advances of about ¼c. per lb. Lead has been stationary. Fewer fluctuations have occurred in tin than are ordinarily recorded. We quote at Chicago as follows: Casting copper, 14.25c.; Lake, 14.50c., in carloads, for prompt shipment; small lots, ¼c. to ⅜c. higher; pig tin, carloads, 45.50c.; small lots, 47.50c.; lead, desilverized, 4.40c. to 4.45c., for 50-ton lots; corroding, 4.55c. to 4.60c. for 50-ton lots; in carloads, 2½c. per 100 lb. higher; spelter, 6.30c. to 6.40c.; Cookson's antimony, 8.75c., and other grades, 7.75c. to 8.25c., in small lots; sheet zinc is $8.25, f.o.b. La Salle or Peru, Ill., less 8 per cent. discount, in carloads of 600-lb. casks. On old metals we quote buying prices for less than carload lots: Copper wire, crucible shapes, 11.75c.; copper bottoms, 10.50c.; copper clips, 11.50c.; red brass, 10.50c.; yellow brass, 8.25c.; lead pipe, 4c.; zinc, 5c.; pewter, No. 1, 26c.; tinfoil, 33c.; block tin pipe, 38c.

Iron and Industrial Stocks

NEW YORK, January 2, 1912.

The stock market was slightly depressed for a day or so when reports of diminished railroad earnings came out, but a recovery quickly followed. Iron and industrial stocks have been particularly firm. The range of prices on active iron and industrial stocks from Wednesday of last week to Tuesday of this week was as follows:

Allis-Chalmers, com.	1½-	Nat. En. & St., pref.	94¾- 94⅞
Allis-Chalmers, pref.	7½- 8	Pressed Steel, com..	33½-
Baldwin Loco., pref.	103¾-103⅞	Pressed Steel, pref..	102 -
Beth. Steel, com....	30½- 32¾	Ry. Spring, com....	30¾- 32
Beth. Steel, pref....	59 - 62	Republic, com.....	25½- 27½
Can., com.....	10⅝- 12⅜	Republic, pref.....	84 - 85¼
Can, pref.....	89¾- 95¼	Sloss, com.....	44 -
Car & Fdry., com...	53½- 55½	Pipe, com.....	16⅛- 16¼
Car & Fdry., pref..	117¼-	Pipe, pref.....	50¾- 52¼
Steel Foundries.....	33¾- 34	U. S. Steel, com....	66 - 69½
Colorado Fuel.....	26½- 27¾	U. S. Steel, pref....	110½-111½
General Electric....	153 -155¾	Westinghouse Elec..	65¾- 67
Gr. N. Ore Cert....	37¼- 44⅞	Va. I. C. & Coke....	70 - 90
Int. Harv., com....	106¾-109½	Am. Ship, com.....	50 -
Int. Harv., pref....	120 -	Chi. Pneu. Tool.....	46⅛- 46½
Int. Pump, com.....	33¾- 34	Cambria Steel.....	44⅛- 44¾
Int. Pump, pref....	83 - 83½	Lake Sup. Corp....	26½- 27¼
Lackawanna Steel...	30 -	Warwick	11½- 12
Locomotive, com....	36½- 36⅝	Crucible Steel, com..	11½- 12¾
Locomotive, pref....	105 -106	Crucible Steel, pref.	82¼- 83⅛
Nat. En. & St., com.	13⅞-	Harb. Walk. Ref., pref	99-

Brown Bros. & Co., New York, Philadelphia and Boston, are offering at prices to yield 5½ per cent. $400,000 of a new issue of $650,000 first and refunding mortgage 5 per cent. serial gold bonds of the Rogers-Brown Iron Company, dated January 1, 1910, and due serially January 1, 1913 to 1940. The proceeds of the block of bonds now offered are being applied to the construction of coke ovens at Sykesville, Pa., and to the opening of the Rogers Mine at Iron River, Mich.

The Page Woven Wire Fence Company, Adrian, Mich., will issue $800,000 new 6 per cent. non-cumulative non-voting first preferred stock in exchange for bonds. The outstanding issues will then be: Common, $1,000,000; first preferred, $800,000; second preferred, $800,000, and bonds, $400,000.

Personal

Robert S. Alter, secretary American Tool Works Company, Cincinnati, Ohio, has returned from an extended business and pleasure trip through Europe.

William S. Dickson, general foreman of the Cincinnati Planer Company, has been selected as secretary of the Cincinnati Branch, National Metal Trades Association, succeeding J. M. Manley, who has been chosen civic secretary of the Cincinnati Business Men's Club. It is understood that Mr. Manley will continue to have general supervision over the Metal Trades Association's office.

W. E. Davis, vice-president in charge of sales of the Goulds Mfg. Company, Seneca Falls, N. Y., has just started on an extensive trip in the interests of the company. He proposes to visit its representatives in no less than 36 cities scattered all over this country, from the Atlantic seaboard to the Pacific coast. If everything goes as planned he expects to complete his trip and return to Seneca Falls early in March.

George E. Lees has resigned as advertising manager of the American Vanadium Company, Frick Building, Pittsburgh, Pa., and is now connected with Fuller & Smith, Engineer's Building, Cleveland, Ohio.

H. H. McClintic and C. D. Marshall, of the McClintic-Marshall Construction Company, Pittsburgh, have gone to Panama in connection with large contracts which the company is executing for the canal.

David N. Carlin has been elected president of the Thomas Carlin's Sons Company, Pittsburgh, to succeed his father, W. J. Carlin, deceased. W. G. Carlin continues as vice-president in active management of the shops. George D. Fox, for some years auditor, has been elected secretary and treasurer. George D. Fox and F. M. Alexander have been elected new directors. The company has discontinued its sales office in the Oliver Building and will handle all its business from the works on River avenue, North Side, Pittsburgh.

Wm. H. Connell, Jr., mechanical engineer, has been appointed manager of the Pittsburgh office of the Hilles & Jones Company, Wilmington, Del., manufacturer of punching and shearing machinery, plate bending and straightening rolls, and other rolling mill equipment. This new office is located in room 201 Oliver Building.

Walter J. Jones, consulting engineer, 30 Church street, New York, has been appointed engineer to the Electrical Commission of the city of Montreal. He will have immediate supervision over the work of gathering data and laying out a complete municipal underground system for that city.

Samuel P. Adams, formerly assistant works manager for the Harbison-Walker Refractories Company, Pittsburgh, has been appointed sales manager of the Pyro Clay Products Company, Oak Hill, Ohio.

New Publication

The Metallurgic Industry in Italy. Description of some of the principal works. Cloth; 490 pages. Published by the Associazione fra gli Industriali Metallurgici Italiani, Milan, Italy.

This volume was prepared in view of the expected meeting of the Iron and Steel Institute in Italy last autumn. It is, therefore, printed in English. The contents are arranged in two parts. The first part, comprising 61 pages, is a most interesting guide book, giving descriptions of the Italian cities which were to be covered by the members of the Institute in making a tour of the country. A fine map of Italy accompanies this part. The second part of the book gives detailed descriptions of a great variety of plants not only for the production of iron and steel but also for the manufacture of finished products, including automobile factories, shipyards, foundries and works for the production and manipulation of non-ferrous metals. The book is profusely illustrated and is exceedingly creditable to those who conceived and executed the work. The American reader of this publication will lay it down with a much higher opinion of Italian metallurgical developments and progress than he had previously entertained from the meager information on the subject available in this country.

S. DIESCHER & SONS.
Mechanical and Civil Engineers,
PITTSBURGH, PA.

New Iron and Steel Works Construction

A Summation of Work Completed in 1911 or That Is Now Under Way or Planned for Erection in 1912

Not in many years has so little new construction been under way in the iron and steel industries, or planned for early erection, as is the case at the opening of 1912. In a summary of the new plant coming forward one year ago it was stated that no new steel making capacity was then projected beyond what had been announced at the opening of 1910. Thus two years have gone by with additions and new projects in iron and steel held in abeyance, most of the work done in that time being the completion of what had been started or provided for previous to January 1, 1910. In the past year the only new steel making capacity undertaken has been six 100-ton open-hearth furnaces for the Youngstown Sheet & Tube Company, six 70-ton furnaces for the Pittsburgh Crucible Steel Company's plant at Midland, Pa., and two 60-ton furnaces for the Lackawanna Steel Company at Buffalo. The Corrigan, McKinney & Co. open-hearth steel project at Cleveland has not been fully developed in plan as yet and that of the Michigan Steel Company, in connection with the Detroit Iron & Steel Company blast furnaces at Zug Island, Detroit, is only in the initial stages, though some progress has been made on the organization of the company.

Below is given a statement of blast furnace construction on which work has been completed in the past year, without the blowing in of the furnaces, or on which work is now in progress or to be undertaken in 1912. One year ago we enumerated 17 coke furnaces that were building or planned, their total capacity being 2,220,000 tons a year. Of these four, having a capacity of 620,000 tons a year, were blown in in 1911. They are No. 4 Central furnace of the American Steel & Wire Company at Cleveland, 160,000 tons; No. 4 furnace of the Republic Iron & Steel Company at Haselton, Ohio, 160,000 tons; F and G furnaces at the Lehigh plant of the Bethlehem Steel Company, 300,000 tons. In addition the No. 5 furnace at Gary, 150,000 tons, practically completed in 1909, was first blown in last year. The above total of 770,000 tons compares with new capacity of 1,280,000 tons blown in in 1910, 1,900,000 tons in 1909, 1,200,000 tons in 1908 and 2,050,000 tons in 1907. Thus in five years the active blast furnace capacity of the country has been increased by 7,260,000 tons.

In 1911 only one absolutely new coke blast furnace project has come up in the entire country. It is that of the Oriskany Ore & Iron Corporation, which will build a 70 x 16-ft. furnace at Lynchburg, Va., with a capacity of 45,000 tons. The two new furnaces for the Pittsburgh Steel Company, for which the engineering contract was let recently, were announced one year ago as projected, but nothing was done in 1911. In the table below are given furnaces that have been completed in 1910 but not operated, furnaces on which work is now under way and furnaces which it is planned to build:

	No.	Capacity, Gross Tons
Minnesota Steel Company	2	280,000
Jones & Laughlin Steel Company	1	140,000
Inland Steel Company	1	140,000
Worth Brothers Company	1	125,600
Corrigan, McKinney & Co.	2	240,000
Pittsburgh Steel Company	2	250,000
Rogers-Brown Iron Company	2	240,000
Iroquois Furnace Company	2	240,000
Zenith Furnace Company	1	100,000
Oriskany Ore & Iron Corporation	1	45,000
Alan Wood Iron & Steel Company		(alternate)
Warwick Iron & Steel Company		(alternate)
	15	1,800,000

The No. 4 furnace of the Aliquippa group of the Jones & Laughlin Steel Company was not actually completed until last year and has not yet been operated. The furnaces of the Worth Brothers Company, Corrigan, McKinney & Co., the Rogers-Brown Iron Company and the Iroquois Furnace Company could all have been blown in last year had the market called for their product. The state of the iron trade in 1912 will determine how many of the above listed stacks will be active this year. One of the Rogers-Brown furnaces will go in this month and the second Worth furnace may be put in within a few weeks while No. 1 is being relined. The new Zenith furnace was projected more than a year ago. It is not entirely certain, however, that work will be started on it even this year.

United States Steel Corporation

No new construction of importance was undertaken by the United States Steel Corporation subsidiaries in 1911. Several new projects on which work was well along one year ago have been completed, however, including those of the American Steel & Wire Company in the Birmingham district, the American Sheet & Tin Plate Company and the American Bridge Company at Gary, Ind. Further progress has been made in the new construction work of the Minnesota Steel Company at Duluth. Below is given a statement of the present status of work on new iron and steel plants of various subsidiaries and the progress made in the past year. In addition mention should be made of the extension to the cement plant at Buffington, Ind., which will have a capacity of 4,000,000 barrels a year, giving the cement plants of the Universal Portland Cement Company in that district a total capacity of 10,000,000 barrels a year. The new Buffington plant will probably be completed early in 1912.

Indiana Steel Company

At the beginning of 1911 No. 5 was the only one of the eight furnaces of the first two groups at Gary which had not been operated. It was blown in in March, 1911. The third group of 14 60-ton open hearth furnaces was practically completed before the beginning of last year, but it has not been necessary to operate them as yet. Of the eight blocks of Koppers by-product coke ovens, 70 ovens each, five have been started in the past year; the remainder are in shape for early completion. Gas from these ovens is used at the steel mills for soaking pits and reheating furnaces. The second power house at Gary has been practically completed and much of the equipment installed. There are six units, each of 3000 kw., consisting of electric generators and gas engines using blast furnace gas. The new power house is part of the interchangeable power system of Gary and South Chicago which in addition to supplying power for both of those plants furnishes the electricity for the operation of the American Sheet & Tin Plate Company and the American Bridge Company plants at Gary. The 60-in. universal plate mill was completed and put in operation last year, also two 12-in. mills and a 10-in. bar mill.

Illinois Steel Company

The new light structural mill of 24-in. and 18-in. stands, with capacity of 15,000 tons a month, was completed and put in operation. It was described in *The Iron Age* of June 15, 1911. Work on a new power plant at Joliet is still under way. It will have three gas electric units of 3000 kw. each.

Carnegie Steel Company

At the beginning of 1911 only preliminary work had been done at Girard, Ohio, on the proposed mills for rolling bars, hoops and small shapes, and this project has the same status to-day. As with other companies, the Carnegie Steel Company's improvement work in 1911 has consisted chiefly of replacements and up-keep.

National Tube Company

The continuous skelp mill at the Lorain, Ohio, works and two butt weld mills for small pipe, on which work was in progress one year ago, have been completed and put in operation.

American Steel & Wire Company

The new rod and wire mills in the Birmingham district, which are about a mile distant from the Ensley Steel

Works, were brought near to completion in 1911. Considerable machinery must be installed before the plant can be operated. The output will be about 400 tons of wire products a day.

The new 500-ton blast furnace, which is No. 4 of the Central Works group at Cleveland, was blown in last year.

An interesting feature of the minor improvements of this company last year is the installation at the Trenton Iron Company's works of a second 750-kw. gas electric unit, the gas engine being supplied with producer gas. This is the fourth producer gas engine installed at a Steel Corporation plant. The two apart from the Trenton works are at the Worcester works of the American Steel & Wire Company and the Pencoyd works of the American Bridge Company.

Tennessee Coal, Iron & Railroad Company

The storage reservoir, which has a capacity of 2,500,000,000 gal. of water, supplied by Village Creek, was completed, as well as the 25,000,000-gal. pumping station. The by-product coke works, consisting of 280 ovens, have been completed and a part of the ovens will be put in operation early in 1912.

American Sheet & Tin Plate Company

The new plant at Gary, consisting of two 72-in. plate mills, four jobbing mills and 16 sheet mills, together with a galvanizing department, was completed and has been operated as far as the demand has required.

Among improvements at the various plants of this company one of the most noteworthy was the installation of air cooling systems which have made working conditions more bearable in hot weather and have naturally added to the efficiency of operation.

American Bridge Company

The new plant at Gary, Ind., was put in operation last year. It has a capacity of 10,000 tons a month of fabricated material.

Minnesota Steel Company

In *The Iron Age* of November 30, 1911, the status of work on the new plant at Duluth was given in detail. Several preliminary buildings have been completed, including a machine shop, plate shop, forge shop and concrete block work, together with a power house. The open hearth buildings are well on toward completion, and foundations have been put in for the mills. The two blast furnaces will have 400 tons daily capacity each, and there will be seven open hearth furnaces of 75 tons capacity. a 40-in. blooming mill and a finishing mill for the production of rails, shapes and merchant steel, with a capacity of nearly 1000 tons a day.

Independent Steel Companies

Bethlehem Steel Company

LEHIGH PLANT

Blast Furnaces F and G (22 ft. x 90 ft.) with five McClure stoves (22 ft. x 100 ft. each) were completed and put into blast on March 15 and July 29, 1911, respectively. These furnaces are equipped with new scale cars, Hoover & Mason ore bins, etc. Gas is washed in Steinbart washer towers. Each furnace is blown by two single gas-driven blowing engines, 42-in. gas cylinders by 76-in. air tub by 60-in. stroke, blast furnace gas being used entirely. The engines were built by the Bethlehem Steel Company and are operating in a new power house, 310 ft. by 100 ft., completed early in the year, and equipped with a 40-ton electric traveling crane. A new 6000-hp. boiler house was put into service in September, 3000 hp. of boilers being of the Rust type and 3000 hp. of the B. & W. type. A new Heyl & Patterson casting machine is about completed and will be put into service early in 1912. The company also completed a brick and steel office building for the blast furnace department, as well as a repair shop for the repairing of hot metal and cinder ladles and for general repair work around the furnaces. In the gas engine power house three 1500-kw. power engines have been installed, and are in operation. These were built by the Bethlehem Steel Company and are of the four-cylinder type.

A new two-story brick office building, 22 ft. wide by 66 ft. long, has been built for the iron foundry department. The capacity of the ingot mold section of this foundry was doubled and a 10-ton and a 20-ton crane installed.

The crucible department has been more fully equipped with grinders and a cold saw cutting-off machine, in order to improve the warehouse facilities.

To the drop forge department were added two 1600-lb. and one 2000-lb. drop hammers, with trimming presses, also a 500-ton hydraulic upsetting and forging machine, the latter being of a special design and built by the Bethlehem Steel Company.

In the No. 2 machine shop additional machine tools to the value of $750,000 were added and placed in operation. All of the steam engine drives in the machine shop have been replaced by electric motors, getting electric current from the company's gas-driven power engines.

SAUCON PLANT

To the main boiler plant 3000 hp. of Stirling boilers were added and put in operation in October, 1911. A new 2000-cu. ft. air compressor was installed in the power station for supplying compressed air to the plant. The Bessemer plant was put into service on February 21, 1911. It is blown by a 46 x 84 x 84 x 60-in. Southwark cross-compound blowing engine. The increased quantity of metal produced by the duplex process has necessitated a new 125-ton ladle crane in the open hearth, as well as a new mold yard and other improvements, all of which have been in service for some time. Since the Bessemer plant was started an additional mixer has been installed and put into operation, making two 400-ton mixers in this plant. To the structural mill finishing end a new crane runway and 10-ton crane, 84-ft. span, has been added for the storage and shipping of material. New machines have also been added in the fabricating shop. A new two-story brick office building, 40 ft. x 40 ft., has been completed for the finishing department of the structural mills, and a new brick laboratory has been built for the open hearth and Bessemer plants.

The following improvements are now in course of construction: Four additional large single blowing engines, of the same size as mentioned above, are being built in the company's machine shops, and an additional 2500-kw. power engine is to be installed. Additional electric units are being installed throughout the plant to supersede various small steam users still in service. The work on the new 300-oven coke plant is progressing very well, and the ovens will probably be put in service in July, 1912. The immediate capacity of this plant is estimated at 3300 net tons of coke per day, with an ultimate capacity of 7500 net tons per day. The layout includes a complete plant for reclaiming by-products. The gas from these coke ovens will be used in the various plants of the Bethlehem Steel Company.

One of the large improvements contemplated for the ensuing year is the entire rearrangement and rebuilding of the merchant mills, together with additions, at an estimated expenditure of $500,000.

Lackawanna Steel Company

The principal new construction for 1912 at the Lackawanna Steel Company's plant at South Buffalo, N. Y., will be the erection of an extension to the open-hearth plant, which includes two 60-ton furnaces, a 600-ton hot metal mixer and necessary equipment of cranes, etc.

In the past year there has been completed and placed in operation a continuous merchant mill, consisting of one 6-stand, 12-in. continuous roughing train and four two-stand, 10-in. finishing trains, having a total annual capacity of 120,000 tons of small squares, rounds, ovals and shapes. In addition to the construction of the new merchant mill an extension of 350 ft. was made to the old merchant mill known as No. 6 mill, to provide improved finishing facilities. Extensive improvements have been made to the No. 2 and No. 3 structural mills, including the installation of machines for straightening and cutting off rounds in the No. 2 mill, a new continuous heating furnace, and a new hot saw in the No. 3 mill. The storage bed and finishing facilities for both these mills have been improved and two new cranes added to the storage beds. Improvements at the No. 4 blast furnace include an improved gas washer, consisting of centrifugal dry cleaners and wet scrubbers. There was also installed in the power house a 750-kw. low-pressure turbine generator.

Cambria Steel Company

The important new construction completed in 1911 at the Cambria Steel Company's Johnstown, Pa., plant was as follows: A new Morgan continuous two-strand rod mill with a capacity for 300 tons of rods daily, together with a complete wire plant, including cleaning room, wire-drawing room, annealing room, galvanizing department, equipment for the various kinds of specialties and a copperas plant for the utilization of the waste acid from the cleaning room; the wire department having sufficient capacity to take care of the entire output of the rod mill.

Two merchant mills were built: 1. A 12-in. motor-driven merchant mill for rolling flats, rounds, squares and various special shapes, which is served by a six-stand, 16-in. continuous roughing mill, also motor driven; the entire mill being thoroughly modern and up to date and having a capacity of 75,000 tons per year. 2. An 8-in. motor-driven merchant mill, built along the same lines as the 12-in. mill, and equipped with a six-stand, 10-in. continuous roughing train with motor drive. This mill to take sizes smaller than can be rolled on the 12-in. mill, down to 5/16-in. rounds, and with a capacity of 40,000 tons per year.

Crucible Steel Company of America

The improvements referred to in our new construction article one year ago, as under way at this company's Norwalk, Ohio, plant, and at the Singer and Crescent plants, Pittsburgh, have all been completed, while the improvements at the Atha Works and Park Mill are still in process of completion, and will hardly be ready much before the middle of the coming spring. At the Atha works a large steel structure is being erected to cover the electric and open-hearth furnaces, and additions are being made to the gun and projectile buildings. At the Park works a new boiler plant and a large crane runway have been under construction.

The Pittsburgh Crucible plant at Midland, Pa., which the company bought in March, 1911, is now undergoing considerable changes. Four 70-ton basic and two 70-ton acid open-hearth furnaces are being built, in addition to one 5-ton Heroult electric steel furnace, with necessary soaking pits, buildings, etc. The company is also erecting at that plant a 40-in. blooming mill, under contract with the United Engineering & Foundry Company. The engine to drive this mill is being built by Mackintosh, Hemphill & Co. The Babcock & Wilcox Company has the contract for the erection of a large boiler plant at Midland, in connection with which will be used the Greene stokers. Plans are under way for the erection of the necessary finishing mills in connection with this plant to take the place of some of the less modern mills at other works, which on account of the high cost of operation cannot compete under present conditions. It is proposed that the plant at Midland shall be the most modern works of its kind for the production of the higher qualities of steel, and all plans and improvements are being made with that end in view.

Youngstown Sheet & Tube Company

In September, 1911, an increase of $5,000,000 was authorized in the capital stock of this company, the greater part of it to be spent on a new open-hearth plant at its Youngstown, Ohio, works. It has been decided to build six 100-ton open-hearth furnaces of the stationary type and a 44-in., two-high reversing blooming mill. The machinery and equipment for these additions are now being bought. Up to the present time the company has contracted with the American Bridge Company for the buildings; with the Wm. Tod Company for the blooming mill; with the Mesta Machine Company for a 46-in. and 76-in. x 60-in. cross compound condensing reversing engine and with the Wellman-Seaver-Morgan Company for gas producers.

American Rolling Mill Company

What is known as the East Side plant of the American Rolling Mill Company at Middletown, Ohio, was completed and put in operation in August, 1911. There are three 65-ton open-hearth furnaces, with foundations for a fourth; a 40-in. blooming mill, 24-in. billet and sheet bar mill, eight 30-in. sheet mills and two 30-in. jobbing mills.

Upson Nut Company

The Upson Nut Company, Cleveland, Ohio, began operating its new steel plant in April. This has four 65-ton open hearth furnaces, a 34-in. blooming mill and a Morgan semi-continuous mill consisting of eight stands of 14-in. rolls, four stands of 11½-in. rolls, one stand of 7½-in. rolls and one stand of 8½-in. rolls. The plant has a finishing capacity of 6000 tons per month. It is probable that the Bourne-Fuller Company interests which took over this plant January 1 will add a fifth open hearth furnace, the foundations for which are already in.

Corrigan, McKinney & Co.

Corrigan, McKinney & Co., Cleveland, Ohio, have plans under way for the building of a steel plant in connection with their two River furnaces at Cleveland. It is the intention to build an open hearth plant with eight 60-ton furnaces and slabbing and billet mills. The present plans do not include finishing mills.

Otis Steel Company

The Otis Steel Company, Ltd., Cleveland, Ohio, will be reorganized under the laws of Ohio. A new company is being formed to take over the old, which is an English corporation with headquarters in London, the property being largely owned by English capitalists. Following the formation of the new company the headquarters will be moved to Cleveland. New articles of incorporation have been drawn up providing for a limited capitalization which will later be increased. This new step is believed to be preliminary to the making of extensive improvements, although it is officially announced that the directors have reached no decision regarding new building plans and it may be some time before definite action is taken. The company is hampered for room on its present site and there is the possibility that a new plant will be built on a site near some of the Cleveland blast furnaces.

Sharon Steel Hoop Company

In 1911 the above company completed its new 14-in. strip mill at Sharon, Pa., equipped with Laughlin furnace and 18-in. roughing train and put into service two 500-kw. General Electric generators driven by a cross-compound Hamilton Corliss engine.

Worth Brothers Company

Work at Worth Brothers Company's plant at Coatesville, Pa., last year was confined to finishing up that undertaken in 1909 and 1910. The No. 2 blast furnace could have been finished up and blown in several months ago, but the price of basic iron did not warrant it, but as the No. 1 furnace has been in blast between 18 months and two years the company is now lining up No. 2 to have it ready when trouble develops with No. 1, so that both furnaces can be worked as soon as cost prices can be obtained. Additional heating capacity for the heavy plate mills has been installed, but the market demands have not been such as to warrant lighting the new pits. A hot metal mixer, started in 1910, was put in operation in the early part of 1911. In the tube department an additional skelp mill has been completed, but it has not been necessary to start it. Some new labor saving machinery of a heavier type than heretofore used is being installed and the company is rebuilding and enlarging its No. 1 welding furnace.

John A. Roebling's Sons Company

In 1911 little building was done at the Trenton, N. J., plant of this company, but considerable additional machinery was installed. At its Kinkora Works at Roebling, N. J., there were completed in the year an additional wire mill and the buildings now occupied by the wire cloth departments. A number of improvements are contemplated for the coming building season, but plans are not sufficiently advanced for a definite statement.

Halcomb Steel Company

The company has recently added to its plant at Syracuse, N. Y., a new iron building 110 x 105 ft. to accommodate a 12-in. mill of eight stands of rolls. The mill is electrically driven. An addition to the company's warehouse of 160 x 90 ft. has been made and equipped with modern tools for cutting off and straightening steel. It will permit of carrying a largely increased stock of steel. The new heat treatment plant is housed in an extension to

the annealing department and has a floor space of 40 x 60 ft. The equipment consists of specially designed oil furnaces meeting the various requirements of modern heat treatment work. The plant can commercially heat treat all classes of work. Furnace No. 1 is 14 x 5 ft. for the heat treatment of steel in bar lengths. This furnace treats bars up to 12 ft. by 10 in. round. Furnace No. 2 is of the same design, but for smaller work, such as forgings. Nos. 3 and 4 are intended to be used for the preheating and heat treating of high speed steel. No. 5 is a crucible pot furnace in which steel can be treated in various oils and treating compounds. No. 6 is a large drawing bath 6 ft. long by 1 ft. wide by 2 ft. deep, in which the temper may be drawn at all degrees from zero to 1500 deg. Fahr. The plant is self-contained and is so laid out that the work can be produced with a minimum amount of handling of the product.

Pennsylvania Steel Company

In addition to the improvements announced one year ago to be made in 1911 at the Steelton plant, including 3000 hp. of boilers, new blast furnace stoves, car repair shop, new pit furnaces, gantry storage crane and building for breaking up scrap, the Pennsylvania Steel Company added last year a 300-ton metal receiver and an electric stock yard crane and runway in the open hearth department. It plans to erect in the early part of this year an iron foundry and a small building equipped for an emergency hospital.

Jones & Laughlin Steel Company

At its Aliquippa, Pa., plant the Jones & Laughlin Steel Company completed last year four Talbot open hearth furnaces with a daily capacity of 250 tons each, a 38-in. blooming mill and a 20-in. billet mill. There was built also a second unit of 12 hot tin plate mills, and in October a second rod mill was finished giving the company a total output of 700 tons of rods a day. The Talbot furnaces and the billet mill will be started soon after January 1, the billet mill supplying sheet bars for the tin plate mill. The No. 4 blast furnace of the Aliquippa group was finished last year, but has not yet been operated.

Republic Iron & Steel Company

In the past year no new work of any magnitude was undertaken by the Republic Iron & Steel Company, but it completed its programme of new construction in the Youngstown District. The new open hearth plant, consisting of eight 60-ton furnaces, 40-in. blooming mill and bar and sheet bar mills, was completed and put in operation in June and has been running since that time. The 90-in. plate mill was started in November, the new Haselton No. 4 blast furnace in July and the new 14-16-in. bar mill has just been started up.

Inland Steel Company

The company completed last year at Indiana Harbor, Ind., its new spike, bolt and rivet department with a yearly capacity of 12,000 tons of rivets, 15,000 tons of track bolts and 15,000 tons of spikes. It is now building its second blast furnace which will be in commission early in 1912. It is 21 ft. bosh by 90 ft. high, with a yearly capacity of 140,000 tons.

DeForest Sheet & Tin Plate Company

Considerable electric power and two cold mills have been added at the company's Niles, Ohio, works; also one galvanizing pot and some heavy forming machinery. Plans have been made for increasing the present hot mill equipment to 10 hot sheet mills and four roughing mills and for the installation of a 1500-hp. mixed flow turbo-generator with condenser and accompanying appliances and with a motor and rope drive for five cold mills. Due to the increased demand for its non-corrosive Lohmanized sheets and its galvanized products the company has decided to build a new plant for galvanizing and Lohmanizing and has been receiving bids on its equipment as well as for a steel and concrete building 78 x 200 ft. for housing this plant. A three-motor electric traveling crane will be installed. It is the plan to have these extensions in operation by April 1.

West Penn Steel Company

At its Brackenridge, Pa., plant the West Penn Steel Company will make extensive improvements. An extension is to be added to the main building providing 50,000 sq. ft. more of floor space. The building is to be made 1000 ft. long. It is 80 ft. wide. There will also be a lean-to of 50 x 350 ft. for warehouse and shipping purposes. The new buildings will be of steel construction. The company now has seven hot mills and seven cold mills in its sheet mill equipment; it will add three hot mills and three cold mills and will roll sheets up to No. 10 gauge, 48 in. wide x 144 in. long. When the new mills are finished it is the intention to run the cold mills separately and they will be driven by turbine engine with exhaust steam.

New Construction in Canada

Extensive new construction has been in progress at the leading steel plants of Canada in the past year and further improvements are planned for 1912. A summary is given below:

Lake Superior Corporation

The subsidiaries of the Lake Superior Corporation completed much important work in 1911 at the Sault Ste. Marie, Ontario, works and still have considerable construction under way. A résumé of these improvements is as follows:

LAKE SUPERIOR IRON & STEEL COMPANY

Work completed in 1911: 110 Koppers by-product coke ovens; three 40-ton open hearth furnaces with gas producers; one 500-ton blast furnace; four gas-driven blowing engines and four gas engines and generators of a total capacity of 17,000 hp., together with the necessary gas washing equipment; a coal handling plant capable of handling over 6000 tons in 24 hours; one crane for pig cast house; one crane for open hearth; one electric ingot stripper, with building; extensive improvements to docks and slips.

Under construction and installation: One 350-ton tilting melting furnace for open hearth department; two sets of 4-hole soaking pits, with building; one 2000-hp. gas engine and electric generator, with building; one 1750-hp. turbo generator set; a sulphuric acid plant.

ALGOMA STEEL COMPANY, LTD.

Work completed in 1911: One 18-in. merchant mill; one 12-in. merchant mill; a department for producing all kinds of track fastenings; one substation for receiving the alternating current and transforming it into direct current for the merchant mills; two 65-ton locomotives; motor to drive blooming mill; four locomotive cranes; one Bessemer blowing engine; one 150-ton gas fired mixer for Bessemer department; one soaking pit and gas producer; trestle and tracks for additional coal storage; a new general laboratory; a new general office with which is affiliated a club house for luncheon and residential purposes for the heads of departments.

Under construction and installation: One 35-in. blooming mill, with tables, manipulator and engine; one 32-in. blooming billet mill, with tables, manipulator, shears, intensifier and engine; one 28-in. rail mill with engine; a set of Babcock & Wilcox boilers; 10 special coke cars; 15 flat cars and 25 Hart-Otis general service cars; two 60-ton locomotives; one 1750-hp. turbo generator set.

Dominion Iron & Steel Company

In the past year the Dominion Iron & Steel Company has had the following work under way at its plant at Sydney, Nova Scotia: Erection of No. 8 blast furnace and foundations for No. 7; extension of 100 ft. to iron ore pier; 350 ft. extension of stock yard; addition of a bridge for handling ore; the construction of two 500-ton open hearth furnaces with building; an additional Bessemer converter and building; a new cold finishing mill 500 x 100 ft.; extension to the old cold finishing mill, which is being converted into a bar and rod mill of 175 x 120 ft.; erection of a general office building, four stories, 65 x 135 ft.; a new wire and nail mill, buildings for which cover 3¼ acres. A building is also being erected at the steel plant which will contain two 2000-kw. turbo alternating units with pumping plant. The company has opened three new coal mines in the year and has under construction an additional mine power plant.

Steel Company of Canada

As recently announced in these columns, this company has let contracts for the construction at its Hamilton, On-

tario, plant of a new blooming mill, continuous billet mill and continuous bar and rod mill. The work will be carried on by the Morgan Construction Company, Worcester, Mass. A contract for the blooming mill has been let to the United Engineering & Foundry Company, Pittsburgh.

In the past year the company has added a fourth stove for its B furnace at Hamilton.

Merchant Blast Furnaces

The Rogers-Brown Iron Company is expecting to blow in early in January one of the two new furnaces which it has been building in the past 18 months alongside the two which have been in operation and beside the ship canal which connects the property with Buffalo harbor. These two new furnaces are each about 85 ft. high and 21 ft. diameter in the bosh. Each is served with four stoves 101 ft. high by 22 ft. diameter. This unit of two furnaces has for its blowing power three engines of the Tod horizontal cross compound type, with tandem air cylinders, which are believed to be the largest yet built, the cylinders being respectively 48 in. by 90 in. and 90 in. and 90 in. by 72 in.

Corrigan, McKinney & Co. completed their second new 350-ton blast furnace at Cleveland, Ohio, about June 1. This has not yet been blown in. It is 80 ft. high, 20 ft. in diameter at the bosh and 13 ft. 6 in. at the hearth. This firm also completed a second furnace at Josephine, Pa., last year, but it has not yet been blown in. It is of the same size and capacity as the new River furnace referred to above.

The alternate stack which the Warwick Iron & Steel Company has been building at Pottstown, Pa., in the past year could be blown in if necessary in a few weeks. It can only operate on one of the other two furnaces going out of blast, the company having blowing equipment for but two.

The Andrews & Hitchcock Iron Company has completed a power plant of three units in the past year at its Hubbard, Ohio, blast furnaces—two 250-kw. generators and one 150-kw. generator.

The improvements begun and nearly completed by the Empire Steel & Iron Company, Catasauqua, Pa., in 1911, were chiefly the new Wedge calcining kiln at Oxford, N. J., and a new separating plant at the Oxford mine.

The Alan Wood Iron & Steel Company has the alternate stack which has been under construction at its Swede group at Swedeland, Pa., nearly completed. It will probably be ready for operation in March.

The Oriskany Ore & Iron Corporation, which gave up its lease on the Alleghany and Buena Vista furnaces in Virginia last year, will build a 125-ton furnace at Lynchburg, Va., in 1912. It will be 70 x 16 ft., and will be equipped with four stoves.

The Detroit Iron & Steel Company rebuilt its A furnace at Detroit in 1911 and changed it from a thick-lined funace to a modern thin-lined furnace, using water to cool the shell. This is the first instance of the conversion of a thick-lined into a thin-lined furnace by the retention of the old shell and the building in of a new one.

Announcement was made recently of the probability of the Buffalo Union Furnace Company erecting a blast furnace at Port Colborne, Ontario, at the entrance of the Welland Canal, to take care of its Canadian trade.

New Rolling Mill Work

Considerable new construction is pending at the Alabama City, Ala., plant of the Southern Iron & Steel Company, but the carrying out of the plans is contingent on the consolidation of the company and the Alabama Consolidated Coal & Iron Company, which has been under negotiation for some months.

An important addition has been made to the plant of the Portsmouth Steel Company, Portsmouth, Ohio, in the past year, in the building of eight new sheet mills with equipment and auxiliaries.

The Harrisburg Pipe & Pipe Bending Company, Harrisburg, Pa., has installed a furnace and new machinery in its pipe mill in the past year, increasing the capacity of that department about 50 per cent.

An improvement for which $200,000 was appropriated is nearing completion at the works of Spang, Chalfant & Co., Inc., at Etna, Pa. It is a concrete and steel building, one of the first in the Pittsburgh district used for manufacturing purposes, and will house the company's offices, the machine shop and the coupling tap and coupling forge departments.

The Page Woven Wire Fence Company has completed additional warehouse capacity at its Monessen, Pa., works, at an expenditure of about $10,000.

Improvements which will be made at the plant of the Ashland Steel Company, at Ashland, Ky., this year include the installation of electric cranes throughout the mills to take the place of hydraulic cranes.

The DeBats Crucible Steel Company recently acquired 5 acres of land at Tylerdale, a suburb of Washington, Pa., and will ask bids on a new plant, including a main building 60 x 100 ft., and another 40 x 60 ft. The product will be tool steel and small steel castings. The company has been operating an experimental plant at Zelienople, Pa., for the manufacture of steel by a modification of existing processes.

The Washington Tin Plate Company, Washington, Pa., completed the rebuilding of its plant, increasing it from five to six mills.

The Dinner to Charles M. Schwab

Arrangements have been completed for the complimentary subscription dinner to be given to Charles M. Schwab, president of the Bethlehem Steel Company, under the direction of a committee representing the iron and steel section of the Manufacturers' Club, Philadelphia, Pa. Owing to the limited capacity of the club house, where it was originally intended that the dinner should be given, it has been decided to hold it in the Grand Ball Room of the Bellevue-Stratford Hotel, on Thursday, January 11, at 7 p. m. The honorary chairmen of the committee are John Fritz, Andrew Carnegie and James M. Swank. The chairman is Nathan T. Folwell; assistant chairman, Alfred E. Burk; secretary-treasurer, James W. Nagle. The toastmaster is James Mapes Dodge.

Obituary

COL. CHARLES JAMES, vice-president and general manager of the Kuebler Foundries, Inc., died, after a brief illness, December 23, at Easton, Pa. President William J. Kuebler states that the business will continue as heretofore without interruption or change.

GEORGE M. ELLIOTT, of the Elliott-Blair Cold Rolled Steel Company, New Castle, Pa., died suddenly December 27 of pneumonia.

The Central Tube Company.—An apology is due to the Central Tube Company, whose general offices are in the Lewis Building, Pittsburgh, Pa., for the omission of its name from the list of steel pipe mills given in the article on "The Wrought Pipe Industry," published in *The Iron Age* of December 21. The Central Tube Company has a large plant for the manufacture of black and galvanized wrought merchant pipe at Economy, Pa. It began the manufacture of pipe July 1, 1909, and has steadily built up a more and more important business. The omission of this name was unintentional, being simply an inadvertence. The officers of this company are as follows: Alex Laughlin, president; G. C. Pease, secretary and treasurer; W. F. Ingals, manager of sales; W. F. Hart, assistant to president.

The Carnegie Steel Company is gradually starting up its idle blast furnaces, and last week issued orders to put in operation stacks D and J of the Edgar Thomson group at Bessemer, Pa., which had been banked for some time. No. 1 stack at New Castle, Pa., will also be put on at once and Nos. 3 and 5 stacks at the Ohio works, Youngstown, Ohio. With these last two stacks started up the entire six furnaces at the Ohio works will be in operation.

The rail mill of the Pennsylvania Steel Company, Steelton, Pa., made a record in rolling open-hearth rails for the week ended December 24, when the quantity rolled averaged about 1000 tons a day. In one 12-hour turn 553 tons was rolled.

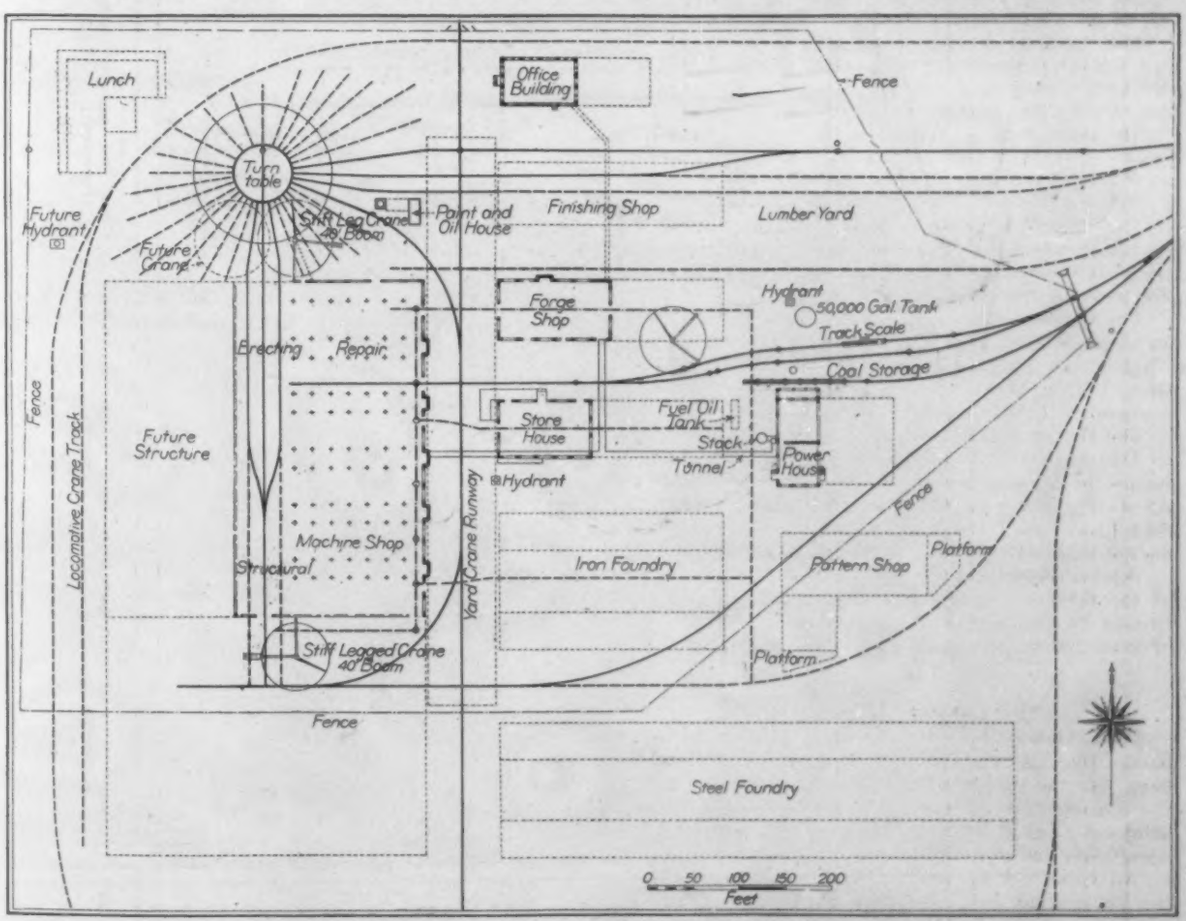
Evansville Plant of the Bucyrus Company

Cost and Design of the Buildings, Method of Handling Material and Products by Tracks and Cranes and Scheme of Equipment

The Bucyrus Company, builder of steam shovels, whose plant at South Milwaukee, Wis., is familiarly known, has built and is about to begin operations in a second plant at Evansville, Ind. Here the South and its development, for which the Panama Canal is already promising a future of large proportions, is immediately at hand. Cheap transportation of fuel and pig iron by river from Pittsburgh and Ohio points, together with favorable labor conditions locally, are regarded as contributing largely to the manufacturing advantages.

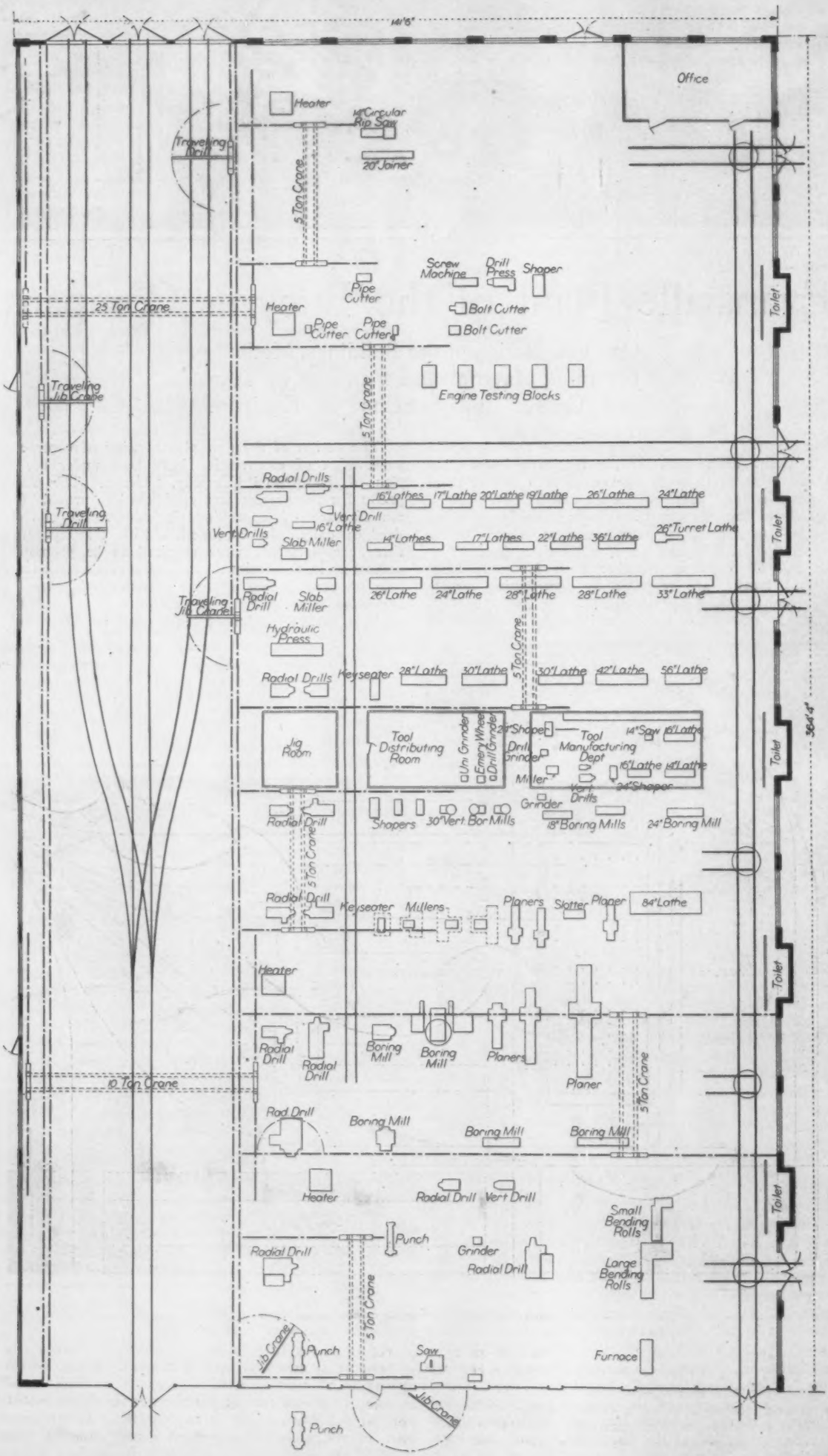
The way was paved for the building of this plant by the affiliation of interest between the Bucyrus Company and the Vulcan Steam Shovel Company at Toledo, Ohio, out of which was evolved the plan of transferring the Toledo plant to the Southern location. More recently a further reorganization of the Bucyrus Company has been accomplished as outlined in *The Iron Age* at the time.

The design of the new plant, letting of contracts and supervision of construction have been under the direction of the Arnold Company, Chicago. The plant capacity for the present was established to provide for the manufacture of approximately five steam shovels or dredges daily. In conjunction with this output basis three considerations were required to be promoted coordinately in the design: 1, a fireproof construction suitable for perpetuating with the growth of the plant; 2, an arrangement adapted for an extension of at least 300 per cent.; 3, the completion of the present buildings with the maximum economy from a standpoint of this initial capacity as an isolated unit.



Block Plan of Buildings and Tracks of the Bucyrus Company at Evansville, Ind.

The estimated cost of the plant as cited in the building permit is $300,000. For a part of the plant the cost of the buildings, including material and erection, ran as high as $1.40 per square foot and for a part as low as



Plan and Equipment of the Main Building of the Evansville Plant of the Bucyrus Company, Accommodating the Machine Shop, Structural Shop and Erecting Floor

$1.20, both figures being unusually low for fireproof steel frame buildings. Aside from the fact that market conditions favorable to buying contributed to the economy thus attained, this object was further conserved in the design

Plan Showing Toilet and Lavatory Arrangement

by the omission of ornamentation, by the use of simple types of steel construction and by a maximum duplication of the construction material units. For example, the roof trusses of the forge shop and those of the erecting bay of the main shop are identical.

The general layout of the plant is apparent from the accompanying block plan of buildings and tracks. This plan presents in addition to that portion now completed the outline of the future extensions as contemplated. The general view of the present buildings given at the head of this article was taken from an upper left point of the plan. The buildings shown are the office building at the extreme left, the power house, forge shop, store house and the main building. The latter houses the machine shop, structural shop and erecting floor. The future buildings as indicated will include an iron foundry, a steel foundry, pattern shop, finishing shop and extensions to all of the present buildings. Until that time, castings will be made at the South Milwaukee plant of the company or elsewhere.

The ultimate plan for handling materials about the plant, both raw and finished, presents two prominent features. Extending from the front of the office building and at a point opposite the main entrance to the plant, the arrangement provides for a main north and south aisle 80 ft. wide. This is to be spanned by a crane traveling the entire length. Abutting the east side of this aisle are the auxiliary and raw material shops, foundries, forge shop and store house, on the opposite side the main or finishing building. In conjunction with the standard gauge industrial trackage system outlined, the cranes on this runway will be the principal transferring medium. For the present this crane is not installed, but a standard gauge track traverses the aisle and upon this locomotive crane service is temporarily substituted.

The second feature is a 65-ft. electrically operated turn table from which radiate numerous stub-tracks for the storage of assembled shovels. The turn table is equipped with a car haul by means of which the shovel may be pulled out of the expensive erecting floor space as soon as possible and shunted to one of the yard tracks or to the outgoing track for shipment. In those portions of the yard where material is to be accumulated, stiff-legged boom cranes with 40-ft. masts and jibs will be mounted, as indicated in the general plan. The yard trackage layout is apparent from the plans. Care has been exercised in the ballasting of all track, in particular as a provision for the concentrated loads which characterize

Movable Supports for Shafting Hangers

the moving of steam shovels and in general as an economical proposition. Seventy-pound rails laid on 7-in. ties are used throughout and the ballast is tile drained.

The main building embraces a large proportion of the distinctive features of the plant. This building is 208 ft. wide and 364 ft. 4 in. long. Of this total floor space the east portion, 141 ft. 6 in. wide, as illustrated in the floor plan of this shop, is occupied by the machine shop and the remaining 66 ft. 6 in. of the width is erecting floor. Covering these two divisions of the floor space, two distinct types of roof construction have been used as indicated in the general photographic view. Over the machine shop, with a clearance of 21 ft. from floor to the bottom chord of the trusses, a saw-tooth construction of simple

View of Forge Shop Interior Before Completion, Showing Supports for Cranes

Fink trussed design is employed. For the erecting floor a monitor type construction is used. The saw-tooth gables run in an east and west direction, affording a south light exposure, while the run of the erecting bay is at right angles in a north and south direction.

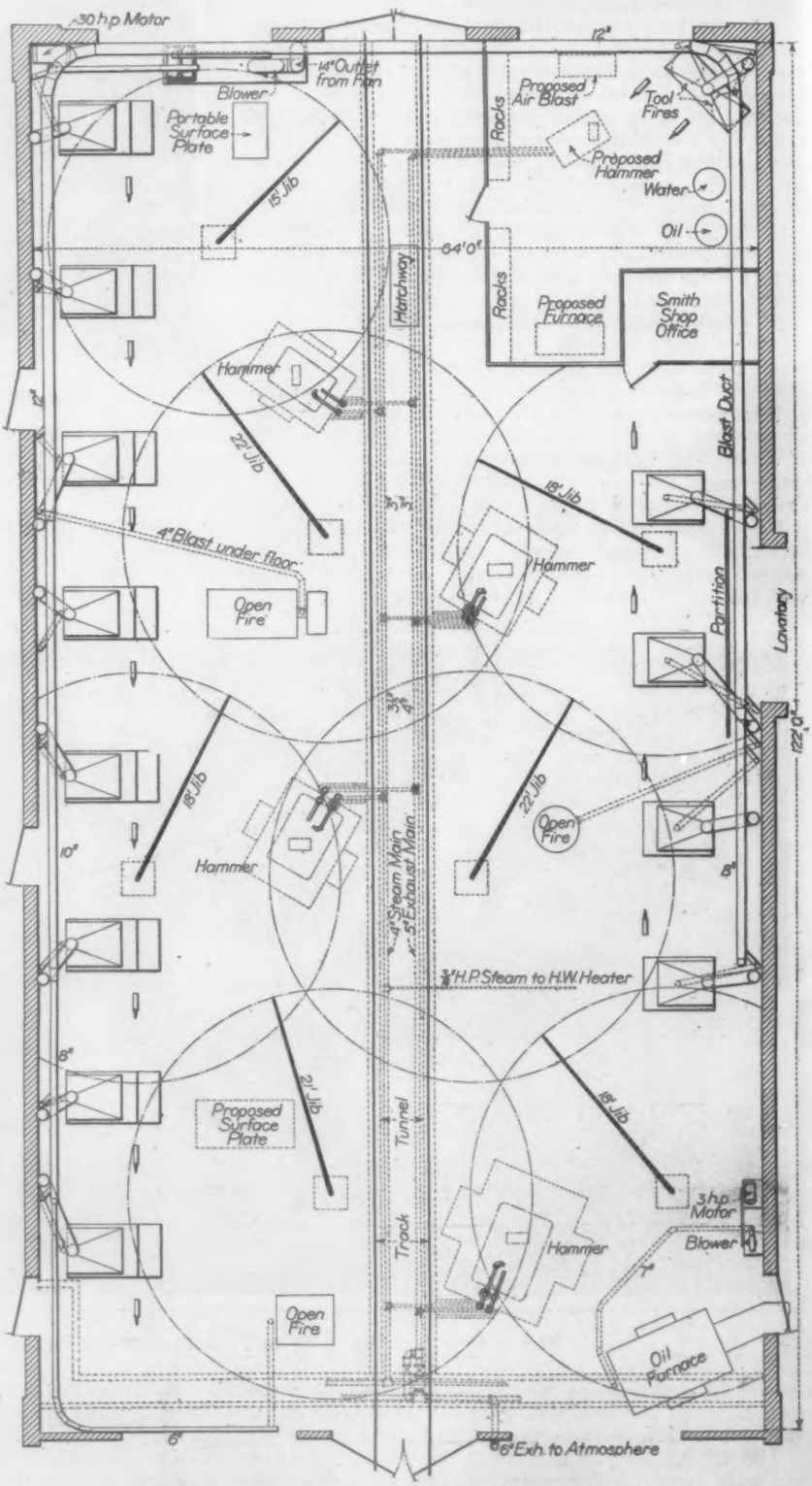
From the layout of the ultimate building as indicated in the general plan it will be seen that the erecting bay now at one side of the building will become a central aisle between the present machine shop on the one side and the future structural shop on the opposite side, the entire building being symmetrical with respect to the center bay. In connection with the building of the structural shop later, space is reserved in the yard between the extreme west building line and the west line of the property for a structural material yard. The plan of handling material will thus provide for the movement of parts to be machined through the machine shop from the one side, and parts to be fabricated from the opposite direction through the structural shop, arriving in the common central erecting bay finished for assembling. For the present the south end of the machine shop and the erecting bay have been fitted up for this structural work.

The manner in which the machine shop floor has been laid out together with the character and location of the tools are indicated in detail. The floor space is divided into six tool bays, the sixth bay being the one now used for structural purposes. Each of these bays is divided into a 20 and a 40-ft. span. In the 20-ft. span all the shafting and transmission equipment for driving the tools is hung, the tools themselves being placed along the columns just inside of the wider span. This width of 40 ft. in each bay is served by a 5-ton Curtis & Co. Mfg. Company traveling crane operated from the floor and traveling across the machine shop from the east side to the erecting floor.

As indicated in the floor plan, an industrial track traverses the machine shop floor along the east side for the length of the shop, with a turn table at the end of each tool bay and connecting with the industrial trackage from the central aisle and auxiliary shops of the plant. The 5-ton crane runways extend over this industrial track at the one end and into the erecting bay under the erecting crane at the opposite end, so that complete facilities for the handling of material are afforded. It can be noted from a survey of the machine tool grouping as illustrated that it is the intention to confine similar machining operations to the one tool bay and to avoid the movement of material, except through this one division of the shop, in which it will be finished complete.

It is estimated that about 15 per cent. of the work of the shop will consist of replacement and repairs. To handle this work without interfering with the regular movement of new material, tool bay No. 3, in the middle portion of the machine shop floor, will be arranged particularly for this work with a direct standard gauge track from the yard trackage system entering and traversing the bay. The tool and stock rooms are placed in the center of the shop.

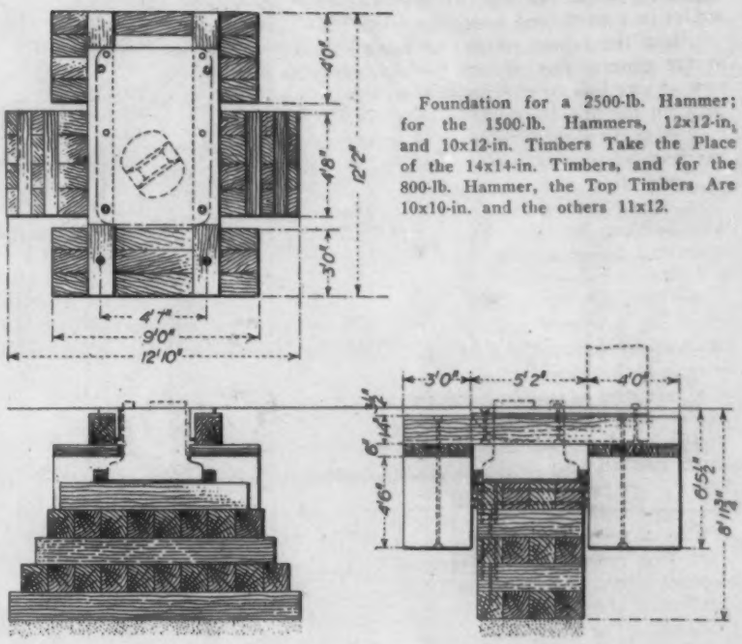
For hanging the transmission machinery and for supporting the overhead motors, an interesting type of steel framing previously employed by the Arnold Company in railroad shops is installed. This framing, shown in an accompanying engraving, consists of two 4-in., 5¼-lb. channels placed back to back with cast iron spool separators 4½ in. long or 2 in. long as may be required. These channels are hung from the I-beams of the roof structure. With these two sizes of separators it is possible to hang from these channels practically the full range of shaft hangers of either two-bolt or four-bolt bases. This spacing allows the bolts to pass up between the backs of the channels and to be secured across the top flanges with clamps and binders. The channel hanger supports are



Plan of Forge Shop, Showing Location of Tools and Jib Cranes

secured to the bottom flange of the I-beams by means of bolted clamps with filler plates. It is thus possible to shift the hanger support along the I-beam to any point or to shift the hanger along its support at right angles to the I-beam at any point, thus giving a complete adjustment in both directions. This system has in addition to its flexibility the advantage of quick adjustment and of obstructing the passage of light much less than would timber framing. Its cost is not greatly in excess of that for timber, and in addition, is in strict accordance with the most severe requirements of fireproof construction.

The soil upon which the machine shop is located is a heavy clay and wet, and to bring the machine shop floor to grade a fill of several feet was required for a large portion of the floor area. The problem was thus presented of putting in concrete foundation of a depth at least as great as the amount of the fill, or of devising a means to avoid this excessive cost. After the fill was made holes about 10 in. in diameter were put down about 3 ft. apart over the entire area of each foundation. These holes were carried to the solid ground below, which varied from a few feet to 12 or 14 ft. When the entire foundation was then poured these holes were filled with concrete and served as concrete piles for the concrete foundation slab which then was required to be only 3 ft. deep. The flooring of the machine tool bay is concrete laid over sand, while in the structural bay a 6-in. tamped cinder floor has been put in.



Foundation for a 2500-lb. Hammer; for the 1500-lb. Hammers, 12x12-in., and 10x12-in. Timbers Take the Place of the 14x14-in. Timbers, and for the 800-lb. Hammer, the Top Timbers Are 10x10-in. and the others 11x12.

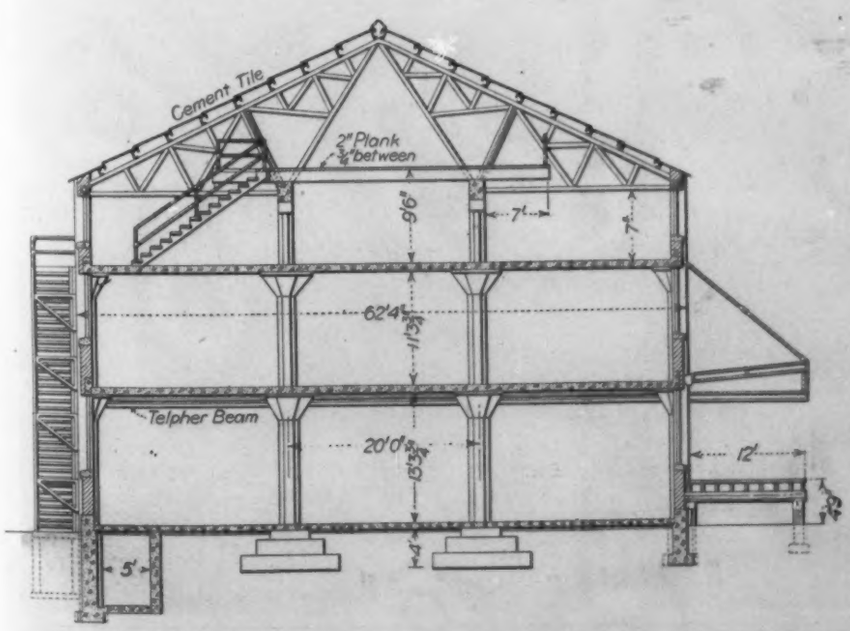
The erecting bay is fitted at each end with unusually large doors permitting the passage of a completed steam shovel with the boom in any position. The floor is traversed by three standard gauge tracks so that the shovels may be erected on their trucks on one or two of the tracks with still a third passing track for the handling of material. The bay is spanned by a 25-ton and a 5-ton crane, and, in addition, is provided with two jib cranes of somewhat unusual arrangement. The manner of installing these is illustrated in the plan The cranes operate one on either side of the bay on 45-lb. monorails, traveling the entire length of the bay and thus being available for light work at any point. Paralleling the jib-crane monorails are two traveling radial drills which combine all of the advantages of a wall radial with the added convenience of being movable to any part of the erecting floor.

The building is an advanced example of proper lighting, heating and sanitary equipment for the employees. Except for the stationary sash in the side walls all of the lighting system, especially the roof lights, are Pond continuous sash furnished by David Lupton & Sons Company, Philadelphia. Tungsten clusters are installed for the artificial lighting. At points of convenient access for the men, sanitary drinking fountains are installed. An accompanying plan illustrates an advantageous method for installing lavatories and toilet facilities. These are uniform for all of the buildings of the plant and are located as indicated in the building plans. In the machine shop a direct heating system is used, with the Baetz air heating apparatus installed by the St. Louis Blower & Heater Company.

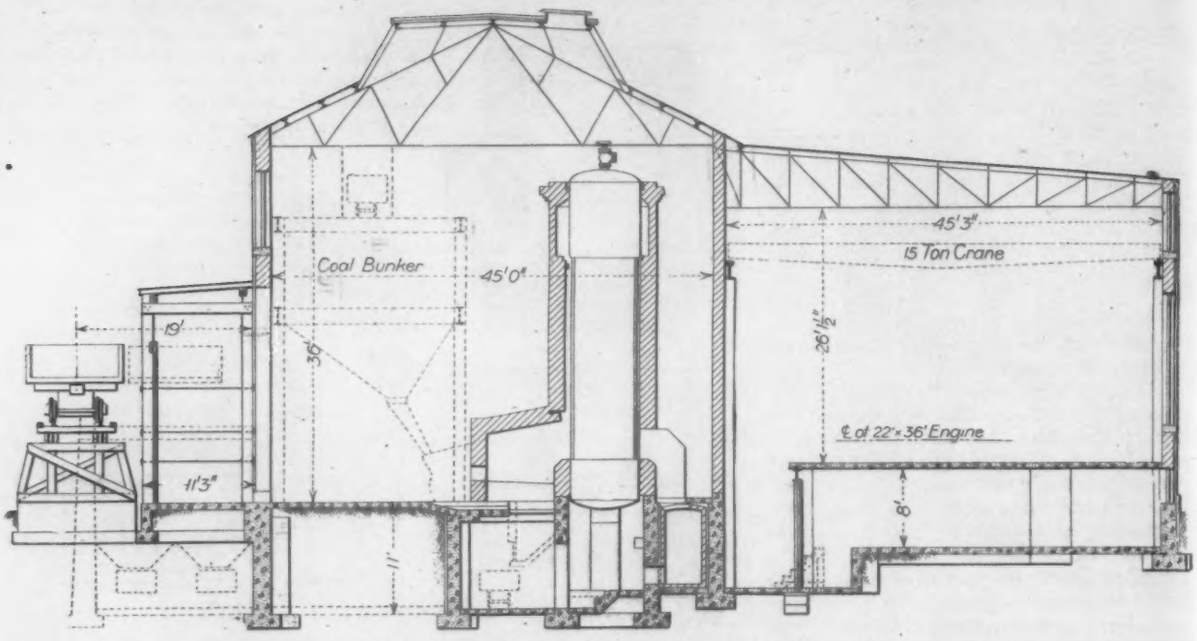
The relative location of the forge shop with reference to the machine shop is apparent from the block plan. The arrangement of forges, hammers and heating furnaces, and the general facilities of the building are presented in a separate drawing. A view of the interior of the forge shop prior to the complete installation of machinery is also shown. Material will be handled in this shop from the industrial track which passes from end to end through the center by seven jib cranes, the arcs of which swing over the entire floor space. One of these is a 15-ft. crane, three are 18 ft., one is 21 ft. and two are of 22-ft. swing. The forges are of simple type built on a concrete foundation with a brick hearth filled in with cinders and a gravity hood.

The size and number of steam hammers to be installed are indicated and the foundations designed for them are also illustrated. The roof design of this building is identical with that of the erecting bay in the main building. Equipped with Pond continuous sash, it is well designed both for lighting and the egress of smoke. The building is 68 ft. wide by 124 ft. 4 in. long, and the future plan provides for an extension of its length 120 ft. A 6-in. tamped cinder floor is laid in this building. The roofing material, as in all of the buildings of the plant, is federal cement tile.

The store house is a type



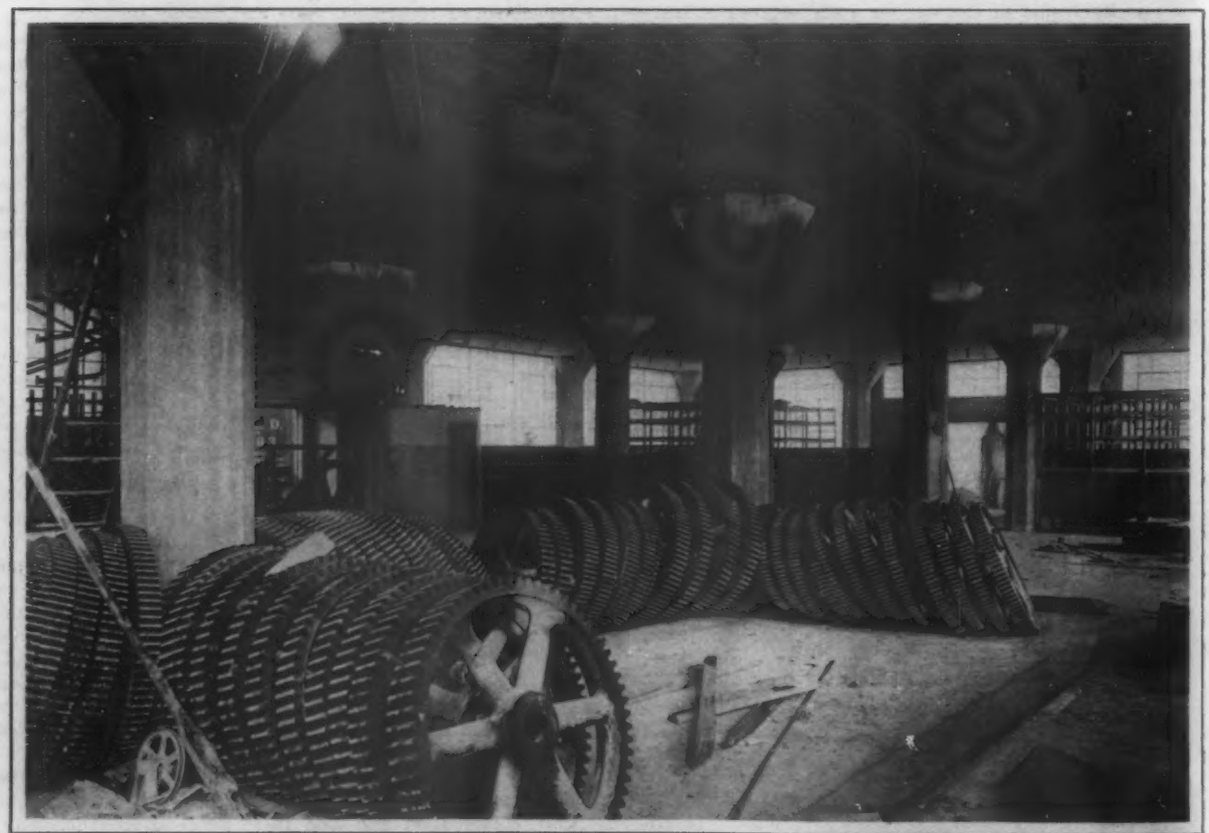
Sectional Elevation of Fireproof Storehouse



Sectional Elevation of the Power House of Bucyrus Plant, Evansville, Ind.

of absolutely fireproof reinforced concrete construction of the mushroom type. It has a present ground plan of 62 ft. 4 in. by 103 ft. 8 in. with a prospective extension of 139 ft. 4 in. An elevation of this building in cross-section is here reproduced. In addition to affording stories for supplies and all construction material purchased outside of the work, the upper floor of the store house will be used for a pattern shop and storage for the present. A standard gauge track for incoming material parallels the building. A canopied platform for unloading purposes is constructed at car floor height along this side of the building. The handling facilities include a Curtis elevator for carrying material to the upper floors and for handling from the platform to the first floor of the building, overhead I-beam trolleys project out over the platform and extend into the building in a manner suitable for distribution over the floor. A reproduction of a photograph of the interior shows bolts anchored over the entire ceiling. This is true of the second floor as well as the first and is intended to provide for the hanging of trolleys or shafting wherever they may be required. In order to conserve floor space and to promote economy of construction a stairway has been built on the exterior of the building.

The general arrangement of the power plant is shown in cross-section. The arrangement as carried out at present provides simply for hand firing of the boilers, but at the same time it has been laid out, as indicated, with a view to a complete mechanical overhead hopper and stoker feed system with an underground ash pit and tunnel. The present boiler equipment consists of three 250-hp. Wickes vertical boilers. The power equipment consists of a St. Louis Corliss engine direct connected to a 400-kw., 3-phase, 60-cycle General Electric generator. For the con-



View in Storehouse Showing Bolts for Carrying Conveyors Anchored to Ceiling

tinuous current requirement of the plant an induction motor generator set delivering continuous current at 240 volts is installed. The air equipment was brought from the Toledo plant and consists of one Ingersoll-Sergeant and one Ingersoll-Rand compressor. The engine floor of the power house is mounted on concrete piers, permitting all of the pumps and auxiliary machinery to be placed in the basement below. Access to these pumps is equally convenient from a boiler room or engine room.

From the power house the steam and air piping is conducted through a 7-ft. square tunnel to the other buildings of the plant a distance of several hundred feet. This tunnel is substantially built of concrete and has hatchways from the yard surface long enough to let down a length of pipe if repairs are required. In all its branches to the different shops it can be opened up for repairs.

The American 24-In. Lathe

A Recently Developed High Duty Machine Tool with a Number of New Features

Ability to transmit a large amount of power and a new style of speed changing mechanism are the two special features characterizing the new 24-in. high duty lathe which has been recently brought out by the American Tool Works Company, Cincinnati, Ohio. The initial driving power of the tool is high and as the transmission is direct and the gearing consists of but very few parts exceptionally high power is thus transmitted. In general the construction of this lathe follows the same lines as the 30 and 36 in. tools, illustrated descriptions of which appeared in *The Iron Age*, June 1 and March 2, 1911, respectively. Fig. 1 is a view of the new tool, while Figs. 2 and 3 show details, being a section through the geared head and an exterior view of the feed change gear box, respectively.

The construction of the geared head, details of which are given in Fig. 2, is a feature worthy of special mention. Eight spindle speeds are available and the mechanism employed consists of only 12 gears, two frictions and a jaw clutch *a*, which is used for direct speeds. The various speeds secured range in geometrical progression from 7.3 to 270 r.p.m. The drive is direct and this arrangement together with the elimination of all loose running members in the head, it is pointed out, results in the securing of a minimum transmission loss and the consequent delivery of a maximum amount of power at the tool. All the gears at the head are of coarse pitch with very wide faces and are mounted on short rigidly supported shafts to eliminate as far as possible vibration and chatter. The frictions *b* used in this head have an ample contact area and are

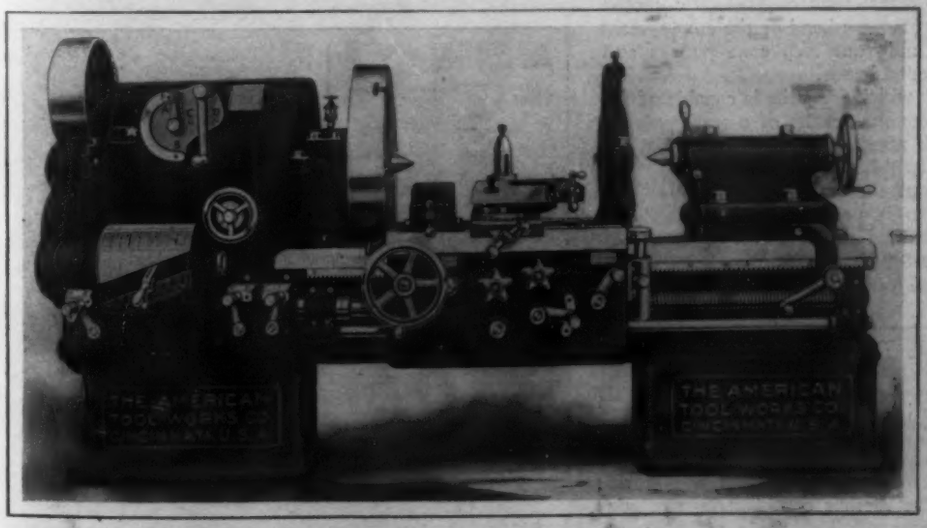


Fig. 1—A New 24-In. High Duty Lathe Built by the American Tool Works Company, Cincinnati, Ohio

located on the initial driving shaft, where they obtain the benefit of a constant speed. This speed is very high on account of the large gear ratio and this together with the size and location of the frictions is said to insure an ample transmission of power without slipping. The back gears *c* are slid in and out of mesh as may be required. A special lubricating system is used in this head, the spindle bearings being supplied with sight feed oilers and all the other are bronze bushed. In the construction of these bushings a recess has been formed to retain the oil which is

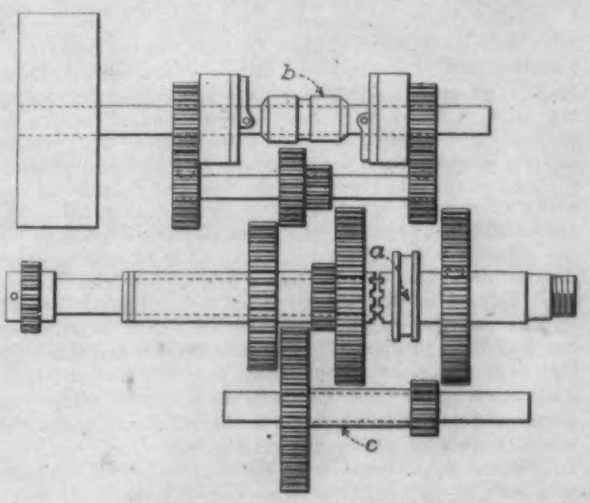


Fig. 2—Detail of the Speed Changing Gear Box

supplied from pipes on the outside of the head. A strip of felt inserted in the recess cut in the bushings feeds the oil into the bearings uniformly over its entire area, filters the lubricant and also prevents it from running out of the bearing. The large diameter driving pulley runs on a bronze bushed steel sleeve which relieves the driving shaft of all strain. The circulating oiling system which has been used by this company on its lathes for a number of years is employed to lubricate the pulley.

Probably the most radical change in design from any similar mechanism is the thread cutting and feed mechanism employed on the new tool. This is of the cone and tumbler type and by the employment of 17 gears and three levers 48 changes are available. These gears are cut from high grade steel castings with a 20-deg. involute Brown & Sharpe cutter. This type of cutter gives the tooth, which is said to be not only very strong, but is also pointed at the top. As compared with the 14-deg. tooth which is generally used this tooth is said to be more easily engaged by reason of its pointed construction and the riding of the gears on top of one another before dropping into mesh is also done away with. An exterior view of the box containing this mechanism is given in Fig. 3. Another special feature of this mechanism is that power can be transmitted directly through the cone gear for cutting coarse threads, an arrangement which eliminates the necessity of speeding up the mechanism with compound gearing to obtain the required speed for the feed screw to cut coarse threads. This arrangement is said to result in the advantage of eliminating power losses in transmission at a time when the greatest amount of power is required for cutting the coarse thread. A quadrant gear on the end of the bed provides a practically unlimited range for feeding and screw cutting for this lathe, as to obtain any thread or feed not listed on the index plate it is simply necessary to figure out the right gear combination and add these gears to the quadrant. The different combinations for obtaining the threads and

the feeds are shown on the change gear box directly over the tumbler lever. The lead screw and the feed rod operate independently, the former being employed for chasing threads only, while the feed rod is used for feeding purposes. When the feed rod is in operation the lead screw is at rest and vice versa.

Double plate construction is employed for the apron, which is also of a new design. In this way an outer support is given to all the studs, including that for the cross feed. The design is said to be very simple and convenient and all superfluous parts have been eliminated to give as direct a drive as possible. Steel is used for all the gears in this mechanism, while the studs are hardened and ground. To prevent the lead screw and the feed rod from being engaged at the same time a non-interfering plate is furnished and is said to be positive in its action. The lubrication of this apron is a special feature. The oil is brought in from the outside of this part through piping and is led to reservoirs formed in the back plate. These chambers are of ample capacity and from them the oil is fed to the different bearings through ducts, the lubricant being filtered and its flow regulated by felt strips placed over the duct openings. This arrangement, it is emphasized, insures a continuous supply of fresh clean oil, while at the same time waste due to the flooding of the bearings is avoided.

The tail stock, which is of the four-bolt type, has been

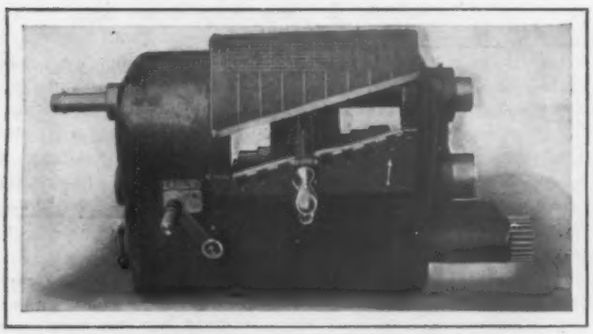


Fig. 3.—The Feed Change Gear Box

made very rigid, the back bolts extending to the top of the barrel, while the front ones are carried a short distance above the tail stock base. Special stress is laid upon the fact that the construction makes it convenient for the operator when clamping the tail stock to the bed. A pawl meshing with a rack cast through the bed also adds to the rigidity of the tail stock. The barrel is solid and an improved form of binder is used for clamping the spindle.

A variety of drives can be supplied for this tool. These include either a belt or direct-connected electric motor drive with the patented eight-speed head or the employment of belt drive with three and four step cone pulleys and double and single back-geared heads.

Some idea of the power which the lathe is capable of developing can be gained from the results of a test made on one of these tools, when it removed machinery steel at the rate of 837 lb. per hour. In this test a ¼-in. cut was taken in a 6-in. piece revolving at the rate of 95.4 r.p.m. This gave a cutting speed of 150 ft. per minute. The feed per revolution was ⅛ in. The amount of metal removed per minute was 50.8 cu. in. or 837 lb. per hour and the horsepower delivered to the tool was 17.6.

Some Recent Mechanics' Tools

Several new tools have been recently added to the line of mechanical machinists' tools, made by the Brown & Sharpe Mfg. Company, Providence, R. I. These tools are all intended for accurate work and the finish and workmanship are the same as the various precision instruments manufactured by this company. The three most recent additions which are illustrated herewith are an improved universal bevel protractor with an acute angle attachment shown in Fig. 1 and a thread tool vernier and a V block and clamp, both of which are illustrated in Fig. 2.

The universal bevel protractor shown in Fig. 1 has an acute angle attachment and is an improvement upon the regular type of instrument which this company has been making for some time. The new type of protractor is designed for all classes of work where angles have to be laid out and the addition of the new acute angle attachment increases its field so that it is practically unlimited. Very

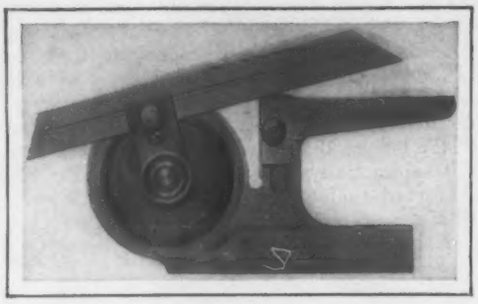


Fig. 1—A Universal Bevel Protractor with an Improved Acute Angle Attachment Made by the Brown & Sharpe Mfg. Company, Providence, R. I.

small angles can be easily and quickly established and great care has been taken in graduating the dial from which the readings are made so that the measurements can be relied on. One of the features of the protractor which tends to add to its convenience is the making of one side of the stock flat so that the instrument can be laid flat on the work or paper. The dial is graduated in degrees throughout the entire circle, and to protect the graduation from wear this surface is depressed slightly. A vernier which reads to 5 min. enables fine measurements to be taken and a small thumb screw on the back makes it easy to secure these fine adjustments.

The new thread tool vernier shown at the left of Fig. 2 is for measuring thread tools of different pitches and its use is said to eliminate the large number of gauges which it was formerly necessary to keep on hand. This is made possible, because when a thread tool is measured the sliding jaw of the vernier can be set to the width of the point of the tool of the required pitch. The tool is then ground down until its point bears on a hardened steel strip inserted in the blade and the sides rest against the jaws. All parts of the vernier which bear upon the tool are hardened and ground to protect them against wear and the angle of the measuring surface is carefully tested for accuracy. The tool has a range covering 1 in. and readings can be taken to 0.001 in.

The third tool shown at the right of Fig. 2 is a V block and clamp which has been designed particularly for laying out work in connection with a surface plate and knee. The blocks which are made of hardened tool steel have the sides ground parallel to each other and the V grooves ground

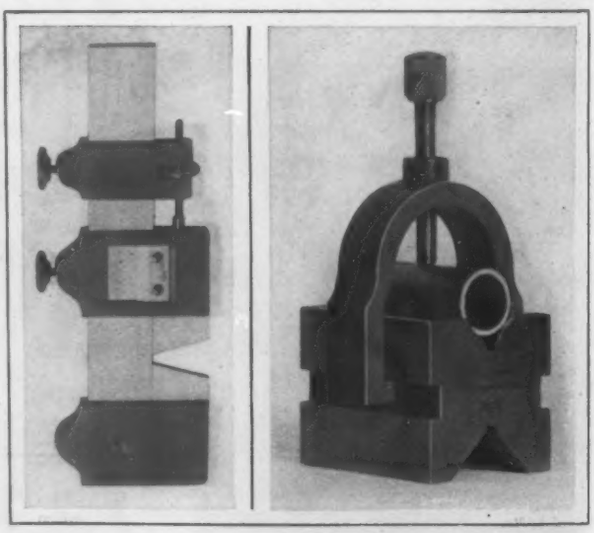


Fig. 2—Two Recently Developed Fine Measuring Tools, a Thread Tool Vernier Caliper and a V Block and Clamp

central and parallel to the bottom and sides. In order that the grooves may be in alignment when it is necessary to use two blocks, each one is numbered and they are sold in numbered pairs only.

The Machinery Markets

Reports from all centers of the machinery trade show expectancy of a good year. Present conditions are somewhat quiet in many cities, although New York has plenty to figure on. The Delaware & Hudson Company has sent out a list of tools required for the new Watervliet shop. Automobile makers are in the New England market and promise business. Cleveland and Cincinnati have some good inquiries. New business is a shade quieter in Philadelphia, but with some inquiries for early delivery. Chicago is optimistic and Detroit has a fair current business. Special machinery demands are active in Detroit. The salmon canning industry is entering the market on the Pacific Coast and other lines are more active. Power equipment is selling well in the South.

New York

Review of 1911

NEW YORK, January 2, 1912.

The New York machinery trade as a whole transacted a large and fairly satisfactory volume of business in 1911 and the books of many manufacturers will show an excellent balance on the credit side when summed up for the year. Makers of woodworking machinery were uniformly busy, as were the makers of many kinds of outdoor equipment. Dredging work, dock building, extensions of city and interurban traction lines, requirements of the Panama Canal, New York City subway extensions and new aqueduct construction, demand for hoisting and conveying machinery and manufacturing enterprises, new and old, are a few of the important sources of good business. The shipyards became more active and are expected to become still more so and good creators of demands. Foreign influences in the latter part of the year made themselves felt to a slight degree. One result of the defeat of reciprocity in Canada was a determination on the part of more American manufacturers to erect plants in the Dominion. The present situation with regard to Russia is a cause of anxiety to machinery houses of international scope, such, for instance, as the makers of mining machinery. They foresaw the danger of trouble at the outset and their fears later found substantiation in consular reports submitted to Washington toward the end of December, which stated that a boycott of American-made machinery was being urged in Moscow and in the city of Kursk, in retaliation for the abrogation of the treaty of 1832 by the United States.

The Machine Tool Trade

Machine tool builders should have done better in 1911. The twelve months just ended were as a whole disappointing to this branch of the trade. Yet, despite the absence of any great amount of big business, there of course have been compensating features, principal among which was the aggregate volume of small and scattered business. These small orders entailed more work and anxiety, also more expense, than big transactions would have done, yet sales of this description saved the situation time and again. At times throughout the year the requirements of automobile manufacturers, while not so large as in previous years, also were a strong factor in the market.

Conditions in the machine tool trade have been greatly affected by the conservative methods of purchasing which have been pursued by several of the large railroad systems. In its issue of January 5, 1911, *The Iron Age* predicted that the railroads would buy sparingly during the year and there can be no question as to the accuracy of the prediction. Instead of issuing lists of generous size and buying proportionately the railroads in many cases have bought in hand-to-mouth fashion, and the influence of their buying has not been felt strongly at any one time. The policy has been one which has kept salesmen on the jump and eaten up many thousands of dollars with the increased cost of traveling and hotel bills, to say nothing of a great deal of lost time.

At the opening of the year machinery men were greatly encouraged by indications of a general betterment in sales. This year they are even more hopeful and optimistic. General conditions in the last few months of 1911 have been steadily improving, and it is felt that the betterment has a more substantial basis than was the case in previous years. Fear of tariff tinkering and the uneasy feeling that accompanies the approach of a presidential campaign are occasionally mentioned in trade circles, but even those who take these influences into their reckoning acknowledge that they will be more than counterbalanced by the actual needs of the country which long have been neglected.

Features of the Year

Immediately following the rosy outlook of early January there was a falling off in the machinery business which left conditions only moderately good. A better tone developed in February, with excellent general machinery demands, and at the close of that month some houses said that they had done better than in any month since March, 1910. Exports were particularly good. Fairly good business continued into March, and in this month manufacturers of some lines did a big business, not equaled again until December. April brought with it the largest list that had come within the year, the specifications for $100,000 worth of tools and special machinery for the American Steel & Wire Company. The demands of automobile manufacturers were also a feature of April. May generally was an indifferent month in a business way, although a saving feature was buying by the Ontario & Western Railroad to the amount of $50,000. June was disappointing. The month of July was better. In August prospects were buoying the dealer up and encouragement was had also from sales of small lots.

With September came a better volume of inquiries and a few good orders were placed; New York dealers received a list calling for machine tools to the value of about $100,000 for South American railroads. Exports were good in point of volume in September and the trade as a whole fared rather well. During both October and November conditions improved, with an increased number of small orders, more inquiries and a growing confidence in the future and what 1912 might bring. In December inquiries were livelier, some good orders were placed by manufacturing interests and a little heavier buying by railroads was noted. At the present writing it is to the railroads that machine tool builders and dealers are looking for big business. The roads have bought heavily of rolling stock and other equipment, and machine tools seem next in order.

Railroad Prospects for 1912

A canvass of railroads as to their probable purchases of shop equipment in 1912, and particularly in the first six months of the new year, discloses some cheering news for machine tool builders and dealers, but replies from a number of companies exhibit a good deal of hesitancy of expression as to their future investments in metal working machinery. Uncertainty as to business and political conditions and in some cases the excessive demands of labor organizations underlie the attitude of a few railroads, according to their statements. Still others, as a matter of policy, say their purchases will be light. But the fact remains that for five years the majority of railroads have neglected the important matter of adequate buying of machine tools and in many cases their equipment is so antiquated and the need of replacement is so urgent that it is difficult to see how they can continue much longer without replacing a large part of the tools so long in use. Economy, which some of the roads advance as a reason for light purchases in 1912, should be in itself a sufficient impelling cause for prompt action in buying. It would seem that the railroads must take advantage of the wonderful improvements which tool makers have effected in their products. Railroad men certainly are cognizant that machine tools have been modernized within very recent date, that new machines have been designed for performing the old tasks and that others of entirely new types have been

created, all for the saving of time and labor and their equivalent—money. And what is true of railroads in this respect also is true of innumerable manufacturing plants.

In the early part of last year it was felt that the railroads would be important contributors to the business of the machine tool builders, yet the months have sped by and while a few large purchases have been made and there has been considerable buying in small lots, it is a fact that replacement has not been commensurate with needs and in many instances has been made only under the direst necessity. Extensions of plant have been regarded as beyond consideration and curtailment has been the rule. In a few cases master mechanics and shop foremen have complained because their requests for new tools were not gratified. That they actually needed equipment for their shops was admitted by some roads in the course of the canvass.

An official of the Wabash Railroad Company said: "It is true, so far as the Wabash is concerned, that heavier purchases of shop equipment would be desirable, but I cannot now forecast that the situation in the next year will be sufficiently improved to warrant any other policy than that which has been pursued during the last three years."

A representative of the Union Pacific wrote: "Business conditions are such that we may find it impossible to ihcur any expenditures along these lines."

An official of the Oregon Short Line stated: "It would be difficult at this time to say just what our requirements will be next year, taking into consideration the adverse legislation against the railroads the past year and the unreasonable demands made upon them by labor organizations which have tended to retard developments that might otherwise have been made."

But not all the roads, by any means, are so dubious as to the future. Among those which have formulated plans or have some intentions of buying machine tools may be mentioned the following:

Missouri Pacific: Expects to purchase in the early part of 1912 shop equipment to the value of approximately $200,000. The most important single item in mind is a 500-ton hydraulic flanging press. A number of pneumatic tools will be purchased also.

Norfolk & Western: Estimates that its shop equipment needs will require an expenditure of $89,500.

Ann Arbor: If earnings hold up, it anticipates starting on a new shop layout which will cost, when completed, from $200,000 to $250,000. Of this $50,000 to $100,000 probably will be expended during the calendar year 1912.

Pere Marquette: Will require machinery for new planing mills in the shops at Saginaw, steam hammer for car department, planer and matcher, one three-spindle car boring machine, two car shop saws, one sash and door mortise.

St. Louis Southwestern: Has in mind the purchase of about $4,000 worth of shop equipment during the year.

Chicago & Northwestern: States that $25,000 probably will be the maximum expended during the year for machine tools.

Philadelphia & Reading: Says that the shop at Reading will require no additions in the near future, but it is proposing to construct a car repair shop in the vicinity of Pottsville in 1912, which will require a moderate amount of machinery, principally that which enters into the reconstruction of cars.

Chicago, Indianapolis & Louisville: Expects at the present time to spend about $10,000 for tools.

Pittsburgh, Shawmut & Northern: States that economy compels it to forego any addition to its shop equipment in the year 1912. Later it will require a very extensive addition to shop equipment, plans for which are being prepared.

Northern Pacific: Is constructing new engine terminals at three points in the State of Washington and some shop equipment will be required.

New York, Chicago & St. Louis: Hopes to make some additions in the way of additional tools and equipment at the Conneaut and Stony Island shops and to conclude the erection of a roundhouse at Conneaut. May also purchase passenger locomotives.

Illinois Central: Its needs will include three 42-in. motor-drive wheel lathes, one 24 in. x 36 in. gear cutter, one automatic power saw, one combination chucking and turret lathe for new work, one 2500-lb. steam hammer, one 12-in. bending roll, one 72-in. half universal drill press, one 36 in. x 14 ft. engine lathe, one 24 in. x 10 ft. planer, one staybolt threading machine, three tool room lathes, five small sensitive drill presses, two portable cylinder boring bars and one 32-in. vertical single spindle drill press.

Southern Pacific: Estimates that its expenditures for shop equipment during the first six months of 1912 will total about $60,000.

Chesapeake & Ohio: At present foresees an expenditure of about $25,000 for new shop tools.

A list of considerable size is anticipated from the Delaware, Lackawanna & Western which will call for a number of heavy tools.

During December it was made known that the Canadian Pacific would spend about $2,500,000 on new shops at Calgary, Alberta, Canada.

The Erie Railroad, while not specifying any machinery needs for 1912, states that its appropriations for shop equipment in its last two fiscal years aggregated about $210,000.

The Week

The year starts well. New in the hands of the trade is the long awaited list of the Delaware & Hudson Company, calling for equipment for its Watervliet shop. These requirements have been anticipated with intense interest for several months. The list is larger than any that came to machine tool builders in 1911. The Delaware & Hudson Company, in its communications to prospective bidders, states that the new shop at Watervliet is not ready to receive the tools, and that date of delivery will be specified in the orders given. The list follows:

The Delaware & Hudson Company's List

One 26 in. extra heavy duty, all-geared head, engine lathe.
One No. 9 motor driven safety grinder.
One 18 in. motor driven, high duty slotter.
One 16 in. medium duty, all-geared head, engine lathe.
One 20 in. medium duty, all-geared head, engine lathe.
One 48 in. full universal radial drill.
One motor driven vertical surface grinder and equipment.
One No. 3½ arbor press.
One No. 4 power hack saw.
One 20 in. back gear and power feed drill.
One No. 3 universal horizontal milling machine.
One No. 4 universal horizontal milling machine.
One No. 4 universal vertical milling machine.
One 34 in. high duty double triple quick stroke extension base crank shaper.
One 20 in. high duty double triple quick stroke extension base crank shaper.
One No. 13 universal and tool grinder machine.
One No. 1 universal tool grinding and shaping machine.
One 42 in. motor driven rapid production vertical turret lathe.
One 90 in. extra high power heavy pattern driving wheel lathe.
One 32 in. extra heavy duty engine lathe.
One 60 in. high speed, high power, plain radial drill.
One 24 in. high duty double triple quick stroke extension base crank shaper.
One 26 in. motor driven high duty slotter.
One 36 x 36 in. x 12 ft. massive type two head planer.
One 42 in. rapid production boring mill.
One 50 ton power forcing press.
One 18 x 44 x 120 in. motor driven gap grinder.
One No. 2 two-head horizontal key-seating machine.
One 30 in. heavy duty engine lathe.
One motor driven horizontal boring mill.
One 20 in. medium duty engine lathe.
One 30 ton power forcing press.
One motor driven link grinder.
One two spindle extra heavy motor driven vertical locomotive boring machine.
One 16 in. medium duty engine lathe.
One 30 ton power forcing press.
One No. 4 motor driven vertical milling machine.
One massive construction, motor driven, horizontal milling machine.
One No. 3½ arbor press.
One 2 in. belt driven triple bolt cutter.
One 1 in. belt driven double head bolt cutter.
One 4 in. belt driven single head bolt cutter.
One belt driven six spindle bolt turning machine.
One belt driven nut facing machine.
One belt driven Acme 2 in. pointing machine.
One belt driven 1½ in. four spindle semi-automatic tapping machine.
One 20 in. back gear and power feed drill.
One 20 in. belt driven lathe.

One 4 x 78 in. three cylinder belt driven forming roll.
One No. 162 belt driven squaring shear.
One belt driven automatic turret lathe.
One No. 56 belt driven automatic turret lathe.
One 6 in. motor driven turret lathe.
One 24 in. high duty shoe and wedge planer.
One 42 in. extra heavy duty engine lathe.
One 48 in. high speed, high power, plain radial drill.
One two spindle motor driven centering machine.
One 64 in. motor driven rapid production boring mill.
One 60 in. gap No. 7-R single punch and self-containing radial crane.
One 36 in. single shear and self-containing radial crane.
One 60 in. single shear and self-containing radial crane.
One 28 in. boiler plate planing machine with screw jacks.
One Three cylinder 16 ft. 0 in. boiler plate bending rolls
One No. 3 15 ft. gap 150 ton hydraulic riveter.
One 30 in. gap horizontal punch.
One special two spindle radial drill.
One 750 ton four column flanging press.
One oil furnace to accommodate four column flanging press.
One two spindle stay bolt threading machine.
One flue welding machine.
One flue welding furnace.
One flue swedging machine.
One six spindle stay bolt threading machine.
One four spindle stay bolt drilling machine.
One flanging clamp with pneumatic cylinders.
One 8 x 11 ft. open forge.
One rail bender.
One 5000 lb. steam hammer.
One 5 ton crane.
One oil furnace to serve 5000 lb. steam hammer.
One 4 x 5 ft. open cast iron forge.
One 18 in. gap No. 7 shears.
One No. 4 cold cutting saw.
One 1½ in. forging machine.
One ¾ in. forging machine.
One 5 x 6 ft. case-hardening furnace.
One 300 lb. steam hammer.
One 600 lb. steam hammer.
One No. 2 bar shears.
One 4 x 5 ft. open forge.
One No. 11 fan.
Portable oil furnaces.
One portable pipe bending machine.
One 6 in. motor driven pipe machine.
One 2 in. motor driven pipe machine.
One No. 3 14 in. gap combination double punch and bar cutting and self-containing crane.
One 60 in. gap No. 3 single punch and self-containing crane.
One 60 in. gap No. 2 single punch and self-containing crane.
One 60 in. gap No. 4 single punch and self-containing crane.
One 4 x 6 ft. open forge.
One 8 ft. bending roll.
One 36 in. gap No. O.R. single punch.
One 42 in. improved high power boring mill with automatic chuck, etc.
One 42 in. extra heavy power wheel lathe.
One 20 in. motor driven massive construction double axle lathe.
One 400 ton motor driven wheel press with all equipment.
One No. 6 column scroll saw to be belt driven.
One 30 in. pattern maker's wood lathe.
One No. 18 double end pattern maker's disc grinder.
One 48 x 6 in. grind stone and box mounted on wheels.

Also before the machine tool trade at the present time is a small list of tools required by the National Railways of Mexico. It includes a couple of turret lathes, a boring mill and a radial drill. The inquiry is taken to bear out the recent reports that confidence is reviving in Mexico and that inquiries for machinery for that country are becoming more actual. The New York offices of the company are at 25 Broad street.

Of interest to the machinery trade was the announcement officially made in the last week of 1911 that the New York, New Haven & Hartford Railroad Company will extend its electric zone from Stamford to New Haven. Construction will begin early in the spring, and the contracts awarded will call for substantially the same kind of materials used in the electrification of the line from New York to Stamford about four years ago. The additional portion of the road to be electrified is 41 miles in length, and it is estimated that the cost of the work will be $4,000,000. In New Haven a large power house will be erected, according to present plans.

A new second-hand machine toolware house has been completed for accommodating the business in used tools conducted by J. J. McCabe, 30 Church street, New York City. It is planned shortly to move into it the machinery now stored in outside places. The McCabe business is claimed to be the largest in second-hand machinery in the country and is the result of a quarter-century of activity in the field.

The Syracuse Ornamental Company, Syracuse, has plans in preparation for its new factory on Free street, which is to be of reinforced concrete construction.

The Harris Grape Juice Company, Penn Yan, N. Y., has plans in preparation for a factory which it will erect, and for which presses and bottling machinery will be required.

The Village Board of Perry, N. Y., is considering the erection and equipment of a municipal lighting plant at an estimated cost of $15,000.

New England

BOSTON, MASS., January 2, 1912.

The machinery builders are beginning the year with an increasing amount of business on their books, and with apparently well-founded hopes that 1912 will prove a marked improvement upon its predecessor. The common opinion seems to be that a presidential year can have few conditions more unsettling to business than those which have characterized the interim since the last national election, and, therefore, whatever improvement may come with the early months of the year will not be counteracted by political developments.

The buying is brisker in the Middle West than in New England, according to the experience of the builders, as well as reports received by local dealers. The automobile manufacturers are in evidence in the market, chiefly because of the extension of the commercial vehicle industry, and also the reorganization which is in process in separating the commercial from the pleasure car as to manufacturing departments, in works which build both. This is in itself a reason for factory extensions and the purchasing of new machinery. The auto truck people expect a year's business well ahead of anything that has preceded it, the demand showing a continuous increase, and builders of pleasure cars are planning a very large output.

The large machine shops of New England are doing little buying. The General Electric Company has placed no orders under the large list which will have to be filled before the new building at Lynn is ready for manufacturing. The United Shoe Machinery Company, usually a continuous factor in the market, is maintaining a policy of no expenditures of funds for this purpose, excepting where it is absolutely necessary. The textile machinery companies, while experiencing some improvement in orders, are not yet doing much buying. The business placed for machine tools by local automobile builders does not total a great amount. The railroads are not putting out new lists, but that of the Boston & Maine, for the great locomotive and car repair shops at Billerica, Mass., will probably be figured this year, aggregating well above $500,000, and perhaps close to $1,000,000. The Grand Trunk will probably need machinery to take care of repairs on the new line from Palmer, Mass., to Providence, R. I., an extension of the Vermont Central. Much miscellaneous business is in sight, recent inquiries being numerous.

The garage trade is a somewhat important item in the machinery and supply trade, and some large establishments of this character are planned for this territory. One such is that of the Rambler Company, which will erect at Boston a four-story, fireproof structure, 127 x 216 ft.

The American Brass Company, Waterbury, Conn., is fitting up a building in which the manufacture of brass and copper bottles will be carried on, which is resuming an industry formerly conducted by one of the companies now included in the American Brass Company.

The Penobscot Chemical Fibre Company, Bangor, Maine, will spend $250,000 on improvements to its plant, to consist, it is stated, of a paper mill which will be operated in connection with the company's pulp mill. A large paper mill usually requires a machine shop of considerable proportions.

The Hartford Builders' Finish Company, Hartford, Conn., will build an addition to its plant, which will be occupied as a sash and blind department and a box factory.

The Hartford Chamber of Commerce Building, Inc., has been organized under a Connecticut charter, and is an assured success, in that all of the necessary capital has been subscribed. A large manufacturing building will be erected. The Arrow Electric Company has offered to take a ten-year lease of the entire structure, and the matter is now under advisement.

Philadelphia

PHILADELPHIA, PA., January 2, 1912.

Machinery merchants have taken a fair run of small orders. Some inquiry for tools for early delivery is noted. The Pennsylvania Railroad has placed orders for a few tools, while negotiations proceed slowly against other railroad inquiries. Orders for the crane equipment of the new erecting shop addition for the Baldwin Locomotive Works, at Eddystone, have been closed.

The general sentiment of the trade is optimistic, not that any heavy buying movement is likely to set in in the immediate future, but the better conditions prevailing in the iron, steel and industrial fields will ultimately lead to increased buying as mills become better engaged and find replacements advisable, if only for economical purposes.

The Mayer & Englund Department of the Electric Service Corporation is considering the installation of a brass foundry in its recently completed fireproof plant at Seventeenth and Cambria streets.

Becker, Smith & Page, wallpaper manufacturers, are taking bids for the erection of a one-story pump house, in which they will install a pump for fire protection, for which the order has not yet been placed.

The Abrasive Material Company, Seventy-first and Upland streets, has awarded the contract for the erection of its new plant at James and Fraley streets to Metzger & Wells, contractors. The company is now considering the matter of its power plant, and may install both steam and electrical equipment. Considerable additional general equipment will be required, although the nature and quantity will not be decided upon for about a month.

The Atwater-Kent Mfg. Company, Sixth street, above Market, has purchased a two-acre tract on Stenton avenue near Fisher's Station, on which a manufacturing building and laboratory will be erected, for which plans will be prepared by John G. Brown, architect and engineer. The building will be 166 x 120 ft. A brass foundry will be included in the new plant, which will be used for the manufacture of automobile and electrical specialties.

Baltimore

BALTIMORE, MD., January 2, 1912.

While the closing month of the year is usually unproductive in the way of any important undertakings or transactions, business in some branches of the iron, steel and machinery trades improved slightly. In the machine tool trade orders have been about the average, and an increase in inquiries is reported, particularly for equipment for delivery early in 1912, but mainly for single tools for replacement and minor extensions. Considerable additional inquiry is coming from ice-making plants and several good contracts for refrigerating and mechanical equipment have recently been let. In mill and machine shop supply lines business has been somewhat irregular. A fair business in small tools is reported. A moderate volume of inquiry for special machine tools and general machinery is noted. Pumps and pumping outfits, particularly, have been in better demand. The call for wood-working equipment has been light. A better trend is observed in the demand for boilers and engines, a marked increase in business in December being reported.

Manufacturers and merchants producing and selling equipment identified with plumbing supplies, particularly those used with sewer work, are very actively engaged, due to the beginning of connection work with the new sewerage system, partly completed by the city. This promises a most extensive line of business in the coming year.

Structural material fabricators are less actively engaged. December has proved rather a bare month as far as new contracts are concerned. The bulk of the recent work has been confined to small local buildings, although better business is looked for, particularly in the South, after the turn of the year.

The general opinion prevails that 1912 will be a better year all round. More confidence in the future is expressed, and with an upward tendency in the prices of iron and steel products both manufacturers and merchants look forward to a more profitable season. Considerable new work is under negotiation in many lines and a slight uplifting of prices is noticeable in many directions.

L. Grief & Bros. are receiving bids for the construction of a large clothing manufacturing plant to be erected on practically a block of ground at Milton and Ashland avenues. Plans are by Frank & Kavanaugh, architects, and cover a three-story brick building of fireproof construction, providing about 20,000 sq. ft. of floor space. The nature of the power equipment, which will probably include both steam and electric power, as well as the elevator installation, is now being considered.

The Potapsco Iron Works, manufacturer of structural and ornamental iron work, which has been in operation for a little over a year, was recently incorporated with a nominal capital. Warren L. Baker, formerly connected with the Chesapeake Iron Works, is president; Jacob Ebert, vice-president and general manager, and Gordon L. Albaugh, secretary. The company reports a fair amount of small contracts and early in 1912 will consider the installation of additional equipment.

The City Ice Company has been incorporated with William G. Green, president; James M. Seitz, vice-president and general manager; William C. Korb, secretary-treasurer, and A. R. Strickler, superintendent. A plot of ground has been acquired on Falls Road, between Twenty-eighth and Twenty-ninth streets, on which will be erected a 2½-story brick and concrete ice plant and storage house, 110 x 275 ft. The contract for the refrigerating machinery and general mechanical equipment has been given to the York Mfg. Company, York, Pa., which will act as general engineer.

W. P. Waxter & Son, Mt. Winans, Md., ice manufacturers, will double the capacity of their plant and have let the contract for a 50-ton ice-making machine and the necessary mechanical equipment to the York Mfg. Company. Several small orders for minor equipment have been placed with local concerns, purchases of which character will later be more extended.

It is stated that the Independent Ice Company has purchased a lot of ground adjoining its present plant on Holliday street and that it will erect an addition doubling the capacity of the present plant. Particulars will probably be available early in January.

It is stated that the American Propeller Company, Washington, D. C., is seeking a factory site in Baltimore for the manufacture of wooden propellers for aeroplanes.

Announcement is made of the selection of Wyatt & Noeting as architects for preparing plans for a new physical laboratory at Homewood for the Johns Hopkins University. The building is to be two stories.

The Wurzburger Brewing Company has filed articles of incorporation. Leon S. Wurzburger is president; Isadore Lowenstein, vice-president, and J. F. Burnett, secretary-treasurer. The capital of the company is $100,000. Plans are under consideration for the erection and equipment of a plant.

Chicago

CHICAGO, ILL., January 2, 1912.

The passing of the year carries with it few regrets from the standpoint of the machinery trade. The average volume of business throughout the 12 months has been from 10 to 15 per cent. below normal, and the irregular spurts have only emphasized a prevailing monotony. Machinery sales have been confined for the most part to one and two tools at a time, and the cost of such sales has been out of proportion to the total volume of business transacted. The recent buying activity of the railroads in other directions is being interpreted hopefully as the forerunner of better things in the next few months, and the close of the year is welcomed as bringing that much closer the advent of more profitable business.

The American Car & Foundry Company, Chicago, has ordered structural steel for the building of a one-story addition to be added to its South Paulina street plant. The building is estimated to cost $50,000.

The Chicago Copper & Chemical Company has been incorporated with a capital stock of $150,000, to engage in the manufacture and refining of ore metal alloys. The incorporators are Winthrop Collidge, C. R. Foster and Frank A. Simmons.

It is understood that the Baldwin Locomotive Works, through agents, has purchased a 156-acre tract on Kedzie avenue, between Thirty-ninth and Forty-third streets, for its Chicago plant.

The Thompson Mfg. Company, Freeport, Ill., has been organized with a capital stock of $10,000, to manufacture and sell machinery and tools. The incorporators are Clement E. Thompson, Louis Strohacker and Edward Strohacker.

The Quincy Casting Company, Quincy, Ill., has been formed with a capital stock of $10,000, to engage in a

general machine and foundry business. The incorporators are Charles Schnellbacher, Lester Willis and George Beals.

The city of Aurora, Ill., has awarded to the Erie City Iron Works, for $12,000, the contract for its new water works power equipment.

The Toledo, Peoria & Western Railroad is building at Galesburg, Ill., a new roundhouse to be 50 x 75 ft.

The Cream City Foundry Company, Milwaukee, Wis., is preparing plans for an addition to its foundry, one story, 70 x 100 ft.

The Milwaukee Yacht & Boat Company, Milwaukee, recently organized, is planning to erect a woodworking shop.

Alonzo Pawling, who recently retired from active connection with the Pawling & Harnischfeger Company, is erecting a four-story factory building, 83 x 97 ft., at Clinton and Oregon streets, Milwaukee.

The J. I. Case Threshing Machine Company, Racine, Wis., is negotiating for a site at Great Falls, Mont., upon which to build a branch house and assembling factory.

Cleveland

CLEVELAND, OHIO, January 2, 1912.

The year 1911 in the Cleveland machine tool trade was generally unsatisfactory. While there was little early in the year to indicate that a good volume of business would come out, still the aggregate business was scarcely up to the expectations. All totals have not been figured up yet, but dealers generally did a smaller volume of business than during 1910. The falling off in sales was probably principally due to the comparatively light demand from the automobile builders in the central West, who had been heavy buyers of machinery during the few previous years. While considerable business came from this source, it was not in round lots to equip large plants, but mostly for a few machines here and there for moderate additions or replacements. Orders for railroads were also scarce, as during the previous year. Buying throughout the year was very scattered, coming from manufacturers of almost all lines of metal products. Few lists of any size came out. The general conditions did not warrant manufacturers in metal-working lines to make large plant extensions. Machinery orders from this source were usually for small lots of tools. There was a considerable demand from makers of automobile accessories, and many of the new plants that were started during the year were put in operation to make appliances used in connection with the operation of automobiles.

In general machinery lines business with builders of handling equipment during the year has been only fair. The demand for small equipment has been fairly active, but orders for large plants for handling ore and coal have not been plentiful. The general feeling is that in these lines 1912 will show an improvement.

The past week in the machine tool trade has been quiet. A fair volume of business is pending that will probably be closed up at the beginning of the year. Several manufacturers have announced their intention to buy considerable machinery equipment, a few tools at a time, during the coming few months. Inquiries are now pending from Akron, Ohio, for five large boring mills, three of which are to be used in the rubber tire industry.

The Lorain Novelty Company, Cleveland, Ohio, is the name of a new concern that has established a plant on Lorain avenue. The company will do machine work and make dies and small novelties.

The Cleveland Metal Products Company, Cleveland, Ohio, which recently built a new plant, will build an extension the coming spring, doubling the capacity of its japanning department. Its metal-pressing department may also be enlarged. This company is affiliated with the Cleveland Foundry Company, maker of oil stoves, which consumes a large share of its output.

The Electro-Magnetic Appliance Company, Cleveland, has been incorporated with a capital stock of $100,000, to manufacture a new clothes-pressing device. The incorporators are Robert Williams, M. Goodhue, S. H. Blakesley and J. M. Curtiss.

The Ohio Crucible Steel Company, Cleveland, will enlarge its plant by the erection of a one-story brick addition, 35 x 64 ft. An open-hearth furnace will be installed. Air compressors, sand blast and some other equipment will be purchased.

The Harris Automatic Press Company, Niles, Ohio, has contracted for an addition to its plant, 30 x 37 ft., to be used as a forge shop.

The Apple Electric Company, Dayton, Ohio, builder of starters and ignition systems, has completed a large addition to its plant and is putting in considerable new machinery.

The Dayton Engineers & Laboratories Company, Dayton, Ohio, recently moved into a new plant and has bought some new machinery equipment. Another list of machine tools is expected from this company shortly.

The Lagonda Mfg. Company, Springfield, Ohio, has under consideration the enlargement of its plant.

It is reported from New Lexington, Ohio, that the New Lexington Water Company will build a new plant.

The A. E. Hall Pottery Company, Crooksville, Ohio, will build an addition to its plant. A brick building, 80 x 400 ft., one or two stories, will be erected.

The Timken Roller Bearing Company, Canton, Ohio, has received bids for a new power plant. It will have a 700-kw. capacity.

Work will be started shortly on the new plant to be erected in Warren, Ohio, by the Ohio Steel & Wire Company. The plans call for a structural steel building, 80 x 475 ft., with a second-story portion, 80 x 300 ft., of reinforced concrete.

Cincinnati

CINCINNATI, OHIO, January 2, 1912.

Building operations by Cincinnati manufacturers in 1911 involved a large amount of money. The following local firms are among those who built new plants or made extensive additions to those already in existence: The Cincinnati Milling Machine Company, Cincinnati Lathe & Tool Company, Alvey-Ferguson Company, Victor Lamp Company, Incandescent Light & Stove Company, Ahrens Iron Works, Hisey-Wolf Machine Company, Andrews Mfg. Company, Cincinnati Grinder Company, Ohio Pattern Works, United States Electrical Tool Company, R. K. LeBlond Machine Tool Company, Charles Boldt Glass Company and Fosdick Machine Tool Company. The new Ohio Mechanics' Institute was also completed last year, and the large building for the Engineering Department of the University of Cincinnati is partly occupied.

While the year just past was not satisfactory to many machine tool manufacturers, there are others who would be satisfied if they could make the same showing in the coming 12 months. As railroad buying will doubtless be heavier this year, orders from the general trade will also probably be more numerous.

The Superintendents' and Foremen's Club, of Oakley-Cincinnati, held a meeting on the evening of December 28. A. H. Teuchter, president Cincinnati Bickford Tool Company, made a very interesting address on the subject of his recent European tour. H. W. Pierle, advertising manager R. K. LeBlond Machine Tool Company, gave a very instructive talk on the design of the LeBlond heavy duty lathe, assisted by C. W. Moon operating lantern slides.

On the evening of December 28 the Edwards Mfg. Company, Cincinnati, gave a banquet at the Business Men's Club, at which were present its local employees and outside salesmen, including a large number of its foreign representatives. President E. W. Edwards made the principal address.

The Longest Brothers Company, Louisville, Ky., is inquiring in this market for a second-hand 18 or 20-in. engine lathe.

The Algonquin Light, Heat & Power Company, Dayton, Ohio, has been incorporated with $10,000 capital stock. No information as to its plans is yet available. J. Elliott Pierce is one of the incorporators.

Frank Andrews, Lebanon, Ohio, is named as one of the principal incorporators of the Andrews Ice Mfg. Company, newly organized, and it is rumored that the company will erect an ice and cold storage plant.

The Hess Spring & Axle Company, Cincinnati, will soon have plans started for a building that will double the capacity of its Carthage plant. The new addition will be used mainly for the manufacture of a lately patented automobile axle. The architect has not yet been selected.

It is reported that the Galion Iron Works Company, Galion, Ohio, will soon make an extensive addition to its plant.

Architects H. E. Kennedy & Co., Cincinnati, have received contract for a large addition to the Seelbach Hotel, Louisville, Ky., in which considerable power equipment will be installed.

St. Louis

ST. LOUIS, MO., January 1, 1912.

The last week of the old year was a quiet one. The few orders for single tools that came in were for immediate requirement and, as a matter of fact, were really to be reckoned into previous sales. At the same time there is a continuation of the better feeling that has been growing, and the dealers generally see in replacements alone a good business for the coming year, while new requirements are headed in the right direction for good aggregates in comparison with the past year.

The Attica Bridge & Iron Company, Attica, Ind., has completed arrangements to remove its plant to East St. Louis, Ill. The company has acquired a large tract upon which the new plant will be installed in new buildings. It will expend $250,000 in building and plant. The force will be doubled as soon as capacity is provided. The company fabricates structural material and builds road machinery.

The Don Bros. Coal & Coke Company, St. Louis, has purchased extensive coal rights in St. Clair, Randolph and Washington counties, Ill., near Marissa and Tilden, and will proceed to open up the properties in time for operation with the completion of the Southern Traction Company's road, now building.

The East St. Louis Levee & Sanitary Drainage District Board has decided to begin work at once on a pumping station and flood gate to handle water and sewage.

The Crum-Wiley Mfg. Company, Decatur, Ill., has increased its stock from $2,500 to $10,000 for the purpose of equipping a manufacturing plant.

The South

LOUISVILLE, KY., January 2, 1912.

Although new inquiries have been coming in rather slowly the past week, manufacturers and dealers have been kept busy taking care of business already in the market. The outlook is excellent, and the trade generally is facing the new year with optimism. The free movement of tobacco and cotton, the Southern staples, is making money more plentiful, and this, it is believed, will lead to better business in all lines.

A good many sales of power equipment for distilleries and breweries have been reported recently. Usually most of this buying is over early in the fall, but favorable conditions in that trade have produced an unusual amount of late business. Air-compressing outfits, rock drills, etc., used by contractors, have been in good demand.

The organization of the Bristol Chemical Corporation, Bristol, Tenn., with a capital stock of $4,000,000, has been announced. The company, which is backed by John T. Williams, Sr., of New York, will take over the barytes plant of John T. Williams & Son in Bristol, and will enlarge it and erect others.

The Crawford Plumbing & Mill Supply Company, Winston-Salem, N. C., is asking for prices on a 100-hp. Corliss engine and a 100-hp. boiler. Used machinery will be considered.

The Pearl Milling Company, Stony Point, N. C., is in the market for an engine and boiler.

The Planters' Oil Mill & Gin Company, Kosciusko, Miss., is asking for quotations on a 75-kw. single-phase generator, direct connected with an automatic engine.

The Deland Light, Power & Ice Company, Deland, Fla., will buy a 250-kw., 60-cycle, 3-phase generator, director connected with a 4-valve engine.

The College Industrial Association, Central S. C., will purchase equipment for a canning factory. Address J. M. Hancock.

Contracts for the equipment of the new reinforced concrete addition to the plant of the Kentucky Public Elevator Company, Louisville, will be let from the Chicago office of the Witherspoon-Englar Company. The equipment consists of belt-conveying machinery principally.

The Ashland Leather Company, Ashland, Ky., which is rebuilding its plant which was burned several months ago, has increased its capital stock from $125,000 to $200,000 for the purpose of enabling considerable enlargements to be made.

F. M. Crump & Co., 14 South Front street, Memphis, Tenn., are in the market for an engine to be used in pumping.

The Black Mountain Timber & Land Company, Bluff City, Tenn., is reported to be planning the erection of a large sawmill for the development of 600 acres of timberland. The company is said to be financed by Philadelphia interests.

W. J. Fraser, Knoxville, Tenn., is planning the erection of a factory for the manufacture of pearl buttons.

The Mountain Spring Ice Company, E. W. Scholze, superintendent, will erect an addition to its plant and increase its capacity from 60 to 150 tons a day.

The Southern Packing & Provision Company, Memphis, Tenn., which is being organized with $25,000 capital stock, will require refrigerating machinery.

James B. Haggin, Lexington, Ky., has purchased the coal handling and feed plant of John B. Payne and has announced plans for the erection of a large grain elevator.

The Arkansas Lime Company, Ruddells, Ark., is in the market for two 10-ton derricks. Second-hand machinery can be used.

The Vivian Ice, Light & Water Company, Vivian, La., will shortly begin the erection of an ice plant. The company was recently organized, and plans later to construct an electric light plant and water-works system.

The R. D. Cole Mfg. Company, Newman, Ga., will rebuild its plant for the manufacture of metal tanks, which was recently burned. The cost of the building will be $15,000.

The recently burned cotton gin of the Duncan, Okla., Cotton Oil Company, is to be rebuilt. Considerable power machinery will be needed. L. T. Weaver is manager of the company.

Detroit

DETROIT, MICH., January 2, 1912.

The close of the year finds a fair volume of business being transacted in the local machinery market, and prominent merchants express themselves as satisfied both with present conditions and with the outlook for the future. Current sales reported include one comprising seven metal-working tools to an up-state manufacturer and several small lots of woodworking equipment. Some fairly good inquiries are under negotiation and considerable tentative business in the way of special equipment is in sight, details of which are not obtainable at this time. The larger automobile concerns are doing practically nothing in the way of machinery purchases at present, and this is curtailing the demand for certain classes of standard tools. Builders of handling machinery report a good business and excellent prospects. The demand for power transmission is inactive. The foundry situation shows little change, although the tendency is toward more irregularity of operation. Foundry men generally, however, are not complaining of lack of business. Second-hand machinery is in fair demand, the volume of sales of both wood and metal-working tools of this class being larger than for some weeks. Immediate building operations are lacking in interest, but several large propositions are in sight which will shortly come before the trade.

The Abbott Motor Company is reported to have secured a large factory site near the Lozier Motor Company's plant, with the intention of erecting a new plant in the spring.

The American Harvester Company has taken out a permit for the erection of a three-story factory building at Brooklyn avenue and Baker street.

Owing to rapidly increasing business, the Federal Motor Truck Company is taking steps to secure a larger plant.

The Michigan Sugar Company has definitely decided to locate its new sugar factory at Pigeon, Mich. Plans now being drawn for the new plant involve an estimated expenditure of $1,000,000 for the buildings and equipment. The company's headquarters are in the Union Trust Building, this city.

The M. & P. Electric Vehicle Company, maker of automobiles, has increased its capital stock from $10,000 to $50,000.

Eugene C. Goldman, Chicago, has acquired the plant of the Randolph Motor Company, Flint, Mich., formerly operated by the General Motors Company as a part of its truck department. It is stated that the capacity of the plant will be increased by the new owner.

The Adrian Knitting Company, Adrian, Mich., is remodeling a large portion of its plant and will install a considerable amount of new motor-driven textile machinery.

Plans are being formulated by the Lull Carriage Company, Kalamazoo, Mich., for the erection of an addition to its plant to be four stories and about 80 x 300 ft., with equipment sufficient to double the company's capacity.

The Automobile Mfg. & Engineering Company, Marine City, Mich., has commenced the erection of an addition to its factory 50 x 80 ft., and two stories. Some new metal-working equipment will probably be required.

Sheldon & Co., manufacturers of manual training school supplies, Chicago, have acquired the plant of the defunct Atlas Furniture Company at Muskegon, Mich., and will remove its business to that city.

Texas

AUSTIN, TEXAS, December 30, 1911.

Never in the history of the State have prospects for a good crop season been better at this time of the year. With plenty of moisture in the ground now, all danger of cotton being injured next season by any drouth that may occur is practically obviated. It is expected that much cotton will be marketed in the next few weeks, thereby turning a great deal of money into the various channels of trade. Machinery dealers are optimistic as to the prospects of the coming year.

In Mexico the political troubles are apparently in a fair way to be permanently settled, and confidence in the stability of the new government is being rapidly restored. This means much to American manufacturers of mining and other machinery who ordinarily look to that country for a considerable trade.

E. H. Perry, Plainview, has let the contract to the Green, Herr, McNaughton Development Company, of that place, for putting down 10 irrigation wells and the installation of a pumping plant at each well on his land.

The Uvalde Water Works Company, Uvalde, Texas, will install a 150-hp. boiler and a 1250-gal. pump.

The St. Louis, Brownsville & Mexico Railroad will enlarge its shops at Kingsville to almost double their present size. A large amount of new machinery will be installed.

The Alamo Land & Sugar Company, Ebenezer, will construct a large irrigation system, including a pumping plant and distributing canals and ditches.

V. J. Garing, of San Antonio, and associates will install an ice plant at Cotulla.

J. L. Crawford, of Alpine, and associates will install a water works plant and lay a distributing system of pipes for that town.

The Tucumcari Light & Power Company has adopted plans for the new power plant which it will install at Tucumcari, N. M.

J. S. Cross & M. S. Cross will install additional machinery in their large soap factory at Matamoros, Mexico, and make other improvements to the plant.

The San Cristobal Mining Company will install a mill at its property near Parral, Mexico. B. V. Gordon, Parral, is vice-president and manager.

The Esmeralda Mining Company will install considerable new machinery at its mines near Parral, Mexico.

The United Mines Company will install a 50-ton concentrating plant at its mines near Montezuma, Sonora, Mexico.

The Pacific Coast

PORTLAND, ORE., December 27, 1911.

In some lines a good volume of inquiry has come out, leading to the expectation of substantial orders early in the new year. Machine tools, however, continue quiet, with no indication of any general activity.

Considerable business is coming from the salmon-canning and general fishing industry of the coast, both in special canning machinery and boat equipment. About 40 large gasoline boats are being built for this purpose on Puget Sound alone, and many more are under construction on the Columbia River and at San Francisco. Several new lumber steamers will probably be built on the coast during the year. Sawmills throughout Oregon and Washington are now undergoing extensive repairs, and much new machinery is being installed, with many additional orders expected from this source within the next three months.

New bids have been called for on the proposed Government suction dredge to be used on Coos Bay, to be opened February 29.

The Universal Wrench Company is figuring on the installation of a plant at Sellwood, Ore.

O. F. Hullbert and J. F. Eichinger are preparing to start a small machine shop at Sumas, Wash.

The Wilson Bros. Lumber Company, Aberdeen, Wash., will put in a lot of new machinery in February, and a new machine will be installed next month in the Aberdeen Lumber & Shingle Company's mill.

The Central Sash & Door Company, Bay City, Ore., is planning to put in new machinery, increasing its capacity 50 per cent.

The Willamette Iron & Steel Works, this city, has sold a large logging engine to the Madera, Cal., Sugar Pine Company, the machine being the first of a newly-designed model for special service.

The American Lumber Company, Sumas, Wash., is starting work on a large planing mill.

The Wilson Bros. Boatbuilding Company and the Union Fishermen's Packing Company have acquired land near Astoria, Ore., where they propose to install new boat shops.

The Springfield Auto Truck Company has been incorporated at Springfield, Ore., to manufacture automobile trucks. Welby Stevens is president and F. D. Tower manager.

Machinery contracts will be let in the near future for the new mill of the British Canadian Lumber Company on Fraser River, plans for which have been completed by A. Pracna, Vancouver, B. C. An 1800-hp. steam turbine power plant will be installed.

Eastern Canada

TORONTO, ONT., January 1, 1912.

Business activity keeps up as if the season were the early autumn instead of midwinter. It would seem that as if the pressure of the demand for this growing country had got to the point at which it is necessary for operations in workshops to go on all year round with unabated force, as in particularly lively periods manufacturers have to keep plant going day and night.

The Ogilvie Flour Mills Company, Montreal, has decided upon the construction of a large milling plant at some central point west of Winnipeg. It will be equipped with the most modern machinery in every department, and the buildings will be so designed that this capacity can be increased in the future as circumstances may demand.

The Ottawa Iron & Steel Company is incorporated to manufacture structural steel in Ottawa. A site has been selected, and works to cost $150,000 are to be put up.

The Montrose Paper Mills, Ltd., Thorold, Ont., proposes making extensions to its paper mills, requiring one paper machine, six beaters and washers with necessary screens, tanks, etc.; two rotary boilers, necessary finishing machinery, cutters and calenders.

The Jenckes Machine Company, Sherbroke, Que., is about to make arrangements to double the capacity of its shops. New buildings and machinery will have to be provided.

The Dominion Rock Drill Company, Napanee, Ont., will make additions to its factory and equipment.

The D. S. Perrin Company, London, Ont., will buy $80,000 worth of new machinery for the biscuit factory it is to rebuild in that city. The new factory is to cost $200,000.

Plans are being prepared for a cream separator factory to cost $35,000 for the Magnet Cream Separator Company, Hamilton, Ont.

The Canadian Wolverine Company, Chatham, Ont., manufacturer of plumbing supplies, is planning to build an addition to its plant, increase of power and additional machinery.

Frank V. Samwell is undertaking to build new works in Fort William, Ont., for the manufacture of iron and steel pipe.

British Canada Agricultural Tractors, Ltd., E. A. Wild, representative, is contemplating the location of a large factory in Calgary, Alberta, to manufacture agricultural machinery.

The Washington Tin Plate Company, of Washington, Pa., has placed an order with the Westinghouse Electric & Mfg. Company for a total of 16 inductive motors and a motor generator set, aggregating 255 h.p., for use in the tin houses. The original installation in the mill was made several years ago, and consisted of Westinghouse motors of various capacities. There will be two spares consisting of one 20 and one 5 h.p. motor. The motor generator set is 75 h.p. and will be used for supplying direct current to some of the motors in the plant. The motors are the CCL induction type, wound for 220 volts, and are particularly adapted for such work.

Current Metal Prices.

The following quotations are for small lots, New York. Wholesale prices, at which large lots only can be bought, are given elsewhere in our weekly report.

IRON AND STEEL—

Bar Iron from Store—

Refined Iron:
1 to 1⅞ in. round and square ... ℔ 1.70¢
1½ to 4 in. x ⅜ to 1 in. ... ℔ 1.70¢
1½ to 4 in. x ¼ to 5-1 ... ℔ 1.80¢
Rods—⅝ and 11-16 round and square. ℔ 1.80¢

Angles:	Cts. ℔.
3 in. x ¼ in. and larger	1.80¢
3 in. x 3-16 in. and ⅛ in.	2.20¢
1½ to 2½ in. x ⅛ in.	1.95¢
1½ to 2½ in. x 3-16 in. and thicker	1.85¢
1 to 1¼ in. x 3-16 in.	1.95¢
1 to 1¼ x ⅛ in.	2.00¢
⅞ x ⅛ in.	2.10¢
⅞ x ¼ in.	2.15¢
⅝ in. x ⅛ in.	3.35¢
½ x 3-32 in.	4.40¢
Tees:	
1 in.	2.25¢
1¼ in.	2.10¢
1½ to 2½ x ¼ in.	1.90¢
1½ to 2½ x 3-16 in.	2.00¢
3 in. and larger	1.85¢
Beams	1.80¢
Channels, 3 in. and larger	1.80¢
Bands—1½ to 6 x 6-16 to No. 8	2.00¢
Burden's "H. B. & S." Iron, base price	2.95¢
"Burden's Best" Iron, base price	3.15¢
Norway Bars	3.60¢

Merchant Steel from Store—

	℔.
Bessemer Machinery	1.70¢
Toe Calk, Tire and Sleigh Shoe	2.50@3.00¢
Best Cast Steel, base price in small lots	7¢

Sheets from Store—

Black

	One Pass, C.R. Soft Steel.	R. G. Cleaned
No. 16	℔ 2.45¢	2.85¢
Nos. 18 to 20	℔ 2.50¢	2.95¢
Nos. 22 and 24	℔ 2.55¢	3.05¢
No. 26	℔ 2.70¢	3.15¢
No. 28	℔ 2.75¢	3.35¢

Russia, Planished, &c.

Genuine Russia, according to assortment ... ℔ 12 @ 14½
Patent Planished, W. Dewees Wood ... ℔ A. 10¢; B. 9¢ net

Galvanized

Nos. 12 and 14	℔ 2.75¢
No. 24	℔ 3.10¢
No. 26	℔ 3.30¢
No. 28	℔ 3.60¢

No. 20 and lighter 36 inches wide, 25¢ higher.

Genuine Iron Sheets—

Galvanized

Nos. 22 and 24	℔ 5.50¢
No. 26	℔ 6.00¢
No. 28	℔ 7.00¢

Corrugated Roofing—

2½ in. corrugated.	Painted.	Galvd.
No. 24 ... ℔ 100 sq. ft.	$3.75	$4.70
No. 26 ... ℔ 100 sq. ft.	2.85	3.90
No. 28 ... ℔ 100 sq. ft.	2.50	3.65

Tin Plates—

American Charcoal Plates (Per Box)

"A.A.A." Charcoal:	
IC, 14 x 20	$6.35
IX, 14 x 20	7.60
A. Charcoal:	
IC, 14 x 20	$5.30
IX, 14 x 20	5.40

American Coke Plates—Bessemer—

IC, 14 x 20 ... 107 ℔	$4.20
IX, 14 x 20	5.20

American Terne Plates—

IC, 20 x 28 with an 8 ℔ coating	$8.10
IX, 20 x 28 with an 8 ℔ coating	10.10

Seamless Brass Tubes—

List November 13, 1908 ... Base price, 18¢

Brass Tubes, Iron Pipe Sizes—

List November 13, 1908 ... Base price, 18¢

Copper Tubes—

List November 13, 1908 ... Base price, 21¢

Brazed Brass Tubes—

List February 1, 1911. 20¼¢ ℔

High Brass Rods—

List February 1, 1911. 15⅜¢ ℔

Roll and Sheet Brass—

List February 1, 1911. 15⅜¢ ℔

Brass Wire—

List February 1, 1911. 15⅜¢ ℔

Copper Wire—

Base Price, Carload lots mill 15¼¢

Copper Sheets—

Steel Copper Hot Rolled, 16 oz. (quantity lots) ... ℔ 19¢
Sheet Copper Cold Rolled, 1¢ ℔ advance over Hot Rolled.
Sheet Copper Polished 20 in. wide and under, 1¢ ℔ square foot.
Sheet Copper Polished over 20 in. wide, 2¢ ℔ square foot.
Planished Copper, 1¢ ℔ square foot more than Polished.
Tinned, one side, 5½¢ ℔ square foot.

METALS—

Tin—

Straits Pig ... ℔ 47¢ @48 ¢

Copper—

Lake Ingot ... ℔ 15¼@16¼¢
Electrolytic ... ℔ 15¼@15½¢
Casting ... ℔ 15 @15¼¢

Spelter—

Western ... ℔ 7¼@ 7⅜¢

Zinc—

No. 9. base, casks... ℔ 9¢. Open, ℔ 9½¢

Lead—

American Pig ... ℔ 5½@5¾¢
Bar ... ℔ 7 @7¼¢

Solder—

½ & ½ guaranteed ... ℔ 26¾@27¼¢
No. 1 ... ℔ 24½@25 ¢
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No. 1 Aluminum (guaranteed over 99% pure), in ingots for remelting (ton lots) ..21¢
Rods & Wire ... base Price 31¢
Sheets ... Base Price 33¢

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Copper, light and bottoms	11.00
Brass, heavy	8.50
Brass, light	6.50
Heavy machine composition	10.50
Clean brass turnings	8.00
Composition turnings	9.00
Lead, heavy	4.00
Lead, tea	3.75
Zinc, scrap	4.75

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The temper of your mechanics is affected by the temper of your files.

Give them files that slip and skid over their work and the result is dissatisfaction and poor work.

Give them **NICHOLSON** Files which bite into the metal with a zing and they take pleasure and pride in producing first class results.

Which class of men do you want?

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Send for catalog of over 3500 sizes and varieties; what you want is listed there.

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Providence, Rhode Island, U. S. A.

THE IRON AGE

Established 1855 New York, January 11, 1912 *Vol. 89: No. 2*

Casting Steel and Alloys in a Vacuum

Machines and Apparatus that Have Been or Are Now in Daily Use—The Advanced State of the Art of Die Casting

BY E. F. LAKE

While casting metals *in vacuo* is an old principle, it has not not been developed to any extent until quite recently. Occluded gases and those segregated in large enough volumes to form miniature bubbles or the larger blowholes, are only beginning to be recognized as the real injurious elements in metals of all kinds. The oxygen, nitrogen and other elements that form these gases, enter into combination with the elements that are parts of the various alloys from which castings are made and form oxides, nitrides, etc., and thus detrimentally affect the strength, wearing qualities and other properties that it is desirous to obtain in the various metal parts that are manufactured. By melting metals, or casting them in a vacuum, these gases can be almost entirely removed and the mechanical properties of metals or alloys greatly improved. This principle is fast growing in favor and therefore, it may not be very long before casting in a vacuum will be quite common.

A vacuum in connection with melting metals has been used to some extent with very good results. Some metals are very brittle substances and when worked by ordinary methods, cannot be rolled and drawn. When melted in a vacuum, however, they have been drawn into wire for various purposes. Examples of such metals are tungsten and tantalum, which are made into wire for incandescent lamps. Another metal that very difficult to melt in the open air is magnesium and this has been readily melted in a vacuum furnace. This is accomplished by building an air-tight chamber around the melting pot or furnace and pumping out all of the air. An electric current then generates the heat necessary for melting the metal and no oxidation can take place, as the oxygen has been removed, likewise, the nitrides, sulphides, phosphides, etc., do not form and the metal has a more dense, homogeneous grain than can be given it by any other process. No oxidizing effect can, therefore, be given the metal when a good vacuum is obtained and the reducing effect of the atmosphere in the furnace is very slight, even at the highest temperatures.

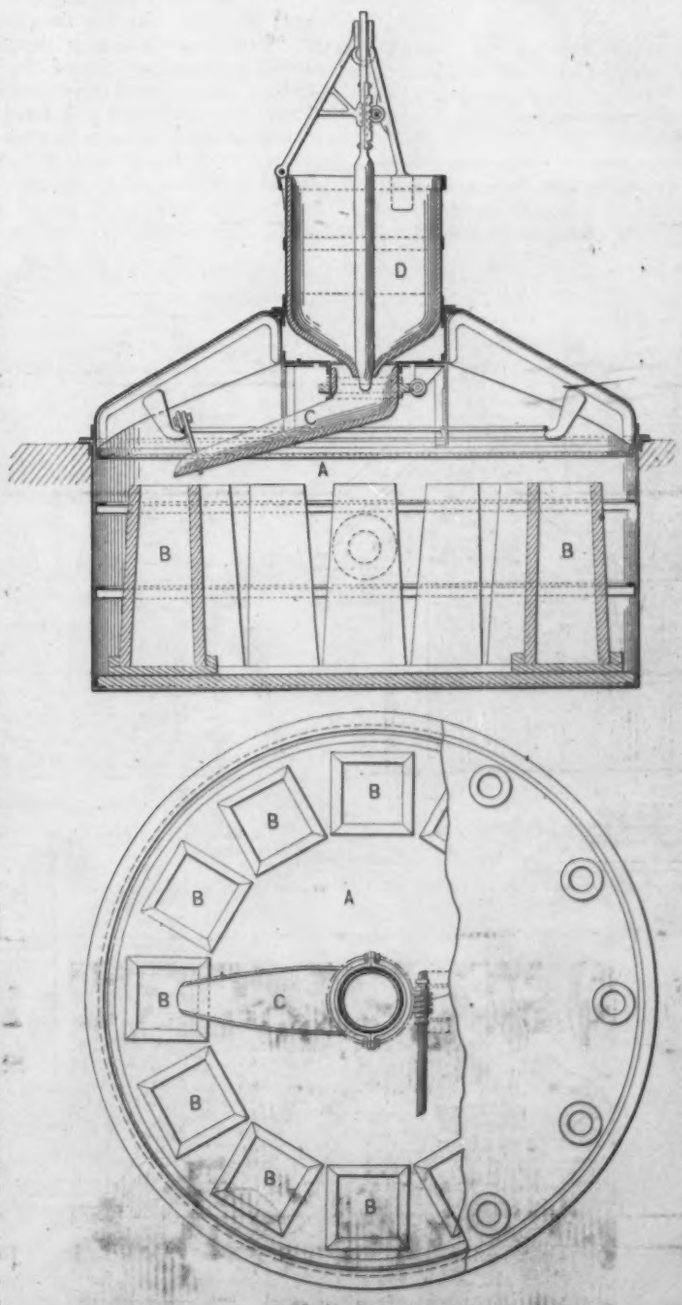

Fig. 1—Teeming Ingots in a Vacuum Chamber

Even though the principle of casting *in vacuo* is very old in this country, the first recorded invention of apparatus for this purpose was that patented by H. V. Barnum, in 1879, as shown in Fig. 2. Here, A is the vacuum chamber, and B a door through which any kind of a mold can be inserted. This door covers the whole end of the vacuum chamber. A clay-lined pot, D, of molten metal is fastened to the top of the vacuum chamber in such a way that no air will be admitted and when the mold is ready to pour,

Current Metal Prices.

The following quotations are for small lots, New York. Wholesale prices, at which large lots only can be bought, are given elsewhere in our weekly report.

IRON AND STEEL—

Bar Iron from Store—

Refined Iron:
1 to 1⅞ in. round and square ... ℔ 1.70¢
1½ to 4 in. x ⅝ to 1 in. ... ℔ 1.70¢
1½ to 4 in. x ¼ to 5-1 ... ℔ 1.80¢
Rods—⅝ and 11-16 round and square ... ℔ 1.80¢

Angles:	Cts. ℔ lb.
3 in. x ¼ in. and larger	1.80¢
3 in. x 3-16 in. and ⅛ in.	2.20¢
1½ to 2½ in. x ⅛ in.	1.95¢
1½ to 2¾ in. x 3-16 in. and thicker	1.85¢
1 to 1¼ in. x 3-16 in.	1.95¢
1 to 1¼ x ⅛ in.	2.00¢
⅞ x ⅛ in.	2.10¢
¾ x ⅛ in.	2.15¢
⅝ in. x ⅛ in.	3.35¢
⅜ x 3-32 in.	4.40¢
Tees:	
1 in.	2.25¢
1¼ in.	2.10¢
1½ to 2½ x ¼ in.	1.90¢
1½ to 2½ x 3-16 in.	2.00¢
3 in. and larger	1.85¢
Beams	1.80¢
Channels, 3 in. and larger	1.80¢
Bands—1½ to 6 x 6-16 to No. 8	2.00¢
Burden's "H. B. & S." Iron, base price	2.95¢
"Burden's Best" Iron, base price	3.15¢
Norway Bars	3.60¢

Merchant Steel from Store—

	℔ lb.
Bessemer Machinery	1.70¢
Toe Calk, Tire and Sleigh Shoe	2.50@3.00¢
Best Cast Steel, base price in small lots	7¢

Sheets from Store—

Black

	One Pass, C.R. Soft Steel.	R. G. Cleaned
No. 16	℔ 2.45¢	2.85¢
Nos. 18 to 20	℔ 2.50¢	2.95¢
Nos. 22 and 24	℔ 2.55¢	3.05¢
No. 26	℔ 2.70¢	3.15¢
No. 28	℔ 2.75¢	3.35¢

Russia, Planished, &c.

Genuine Russia, according to assortment ... ℔ 12 @ 14½
Patent Planished, W. Dewees Wood ... ℔ A. 10¢; B. 9¢ net

Galvanized

Nos. 12 and 14 ... ℔ 2.75¢
No. 24 ... ℔ 3.10¢
No. 26 ... ℔ 3.30¢
No. 28 ... ℔ 3.60¢
No. 20 and lighter 36 inches wide, 25¢ higher.

Genuine Iron Sheets—

Galvanized

Nos. 22 and 24 ... ℔ 5.50¢
No. 20 ... ℔ 6.00¢
No. 28 ... ℔ 7.00¢

Corrugated Roofing—

2½ in. corrugated.	Painted.	Galvd.
No. 24 ... ℔ 100 sq. ft.	$3.75	$4.70
No. 26 ... ℔ 100 sq. ft.	2.85	3.90
No. 28 ... ℔ 100 sq. ft.	2.50	3.65

Tin Plates—

American Charcoal Plates (Per Box)

"A.A.A." Charcoal:
IC, 14 x 20 ... $6.35
IX, 14 x 20 ... 7.60
A. Charcoal:
IC, 14 x 20 ... $5.30
IX, 14 x 20 ... 5.40

American Coke Plates—Bessemer—
IC, 14 x 20 ... 107 lb. ... $4.20
IX, 14 x 20 ... 5.20

American Terne Plates—
IC, 20 x 28 with an 8 lb coating ... $8.10
IX, 20 x 28 with an 8 lb coating ... 10.10

Seamless Brass Tubes—

List November 13, 1908 ... Base price, 18¢

Brass Tubes, Iron Pipe Sizes—

List November 13, 1908 ... Base price, 18¢

Copper Tubes—

List November 13, 1908 ... Base price, 21¢

Brazed Brass Tubes—

List February 1, 1911. 20¼¢ ℔ lb

High Brass Rods—

List February 1, 1911. 15⅝¢ ℔ lb

Roll and Sheet Brass—

List February 1, 1911. 15⅝¢ ℔ lb

Brass Wire—

List February 1, 1911. 15⅝¢ ℔ lb

Copper Wire—

Base Price, Carload lots mill 15¼¢

Copper Sheets—

Steel Copper Hot Rolled, 16 oz. (quantity lots) ... ℔ lb 19¢
Sheet Copper Cold Rolled, 1¢ ℔ lb advance over Hot Rolled.
Sheet Copper Polished 20 in. wide and under, 1¢ ℔ square foot.
Sheet Copper Polished over 20 in. wide, 2¢ ℔ square foot.
Planished Copper, 1¢ ℔ square foot more than Polished.
Tinned, one side, 5½¢ ℔ square foot.

METALS—

Tin—

Straits Pig ... ℔ lb 47¢ @48 ¢

Copper—

Lake Ingot ... ℔ lb 15¼ @16¼¢
Electrolytic ... ℔ lb 15¼ @15⅝¢
Casting ... ℔ lb 15 @15¼¢

Spelter—

Western ... ℔ lb 7¼ @ 7⅝¢

Zinc—

No. 9. base, casks ... ℔ lb 9¢. Open, ℔ lb 9¼¢

Lead—

American Pig ... ℔ lb 5½@5¾¢
Bar ... ℔ lb 7 @7¼¢

Solder—

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